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1883	"	63	" "	1890	"	289	" "
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THE MEASUREMENT OF ENERGY TRANSMITTED BY POLYPHASED CURRENTS.

In this issue we print the first section of an article on the measurement of energy transmitted by polyphased currents. While polyphased currents have already begun to enter largely into use, as shown by the accounts of applications which have been recently appearing in our columns, there has not yet been published in English any other than fragmentary mention as to the methods necessary to be employed in making power measurements. Owing, however, to the complication of making such measurements of alternating currents differing in phase with each other, or when the current is not in phase with the E. M. F., by the use of any of the methods so far proposed which employ voltmeters or ammeters, it is not likely that any of these will be practically employed, in view of the fact that readings can be directly taken from wattmeters. There is, consequently, a large field for the latter in this branch of electrical application, and it is probable that some of those invented in the past but not utilized may now come before the public for this purpose. An incidental benefit of their introduction for use with alternating currents will probably be their more general adoption also for continuous current measurements, where their great convenience does not yet seem to have been fully appreciated.

THE SMALL BOY AND THE RAILROAD TRAIN.

Once upon a time a mischievous small boy escaped from the back yard to which his activities had theretofore been confined and where his sole pleasure had consisted in the bombardment of the windows of a neighboring property with pebbles. Wandering forth into the great world, of which vague though enticing glimpses had been obtained through occasional peeps over the top of a fence, he saw many sights which had previously been beyond the limits of his circumscribed vision and finally spied a railroad train coming in his direction. Our doughty small boy was not of the kind, however, to be frightened by an apparition even as unaccustomed to him as this one, for had he not the recollection of his triumph over the neighboring property which had so meekly borne his constant volleys of pebbles and without even once entering his back yard and spanking him as he knew he ought to have been spanked? So, running in the direction of the approaching train, he assailed it with the same menacing cries that he had found successful in harassing the poultry in his back yard. The fact that his "shoos" did not produce any effect at first, but rather the reverse, mattered not to our rather stupid small boy, and when the train finally passed him and began to recede into the distance, his delight knew no bounds, for had he not put it to a most ignominious flight? And so puffed up is this small boy with his great achievement that as he now struts about his back yard, the neighboring property has lost all interest to him and its windows are free from the quondam pattering of pebbles. Which veracious history is recalled by the boasts of an amusing contemporary in regard to a somewhat similar triumph over a certain programme of the A. I. E. E.

NEW TELEPHONE RATES.

We print elsewhere the new schedule of telephone rates adopted by the Metropolitan Telephone Company, of New York City, based upon the number of calls made by sub-

scribers. While considerable friction may at first result from the new system of charges, there can be no doubt but that it is a rational one and therefore to be preferred to the irrational one of "flat" rates. Under the new schedule the subscriber pays only for the service he receives; if he used a telephone for only a small number of calls he does not have to help to pay for the service of a large user who, in perhaps most cases, is most able to pay for a telephonic service and yet heretofore has not paid his proportionate share of the charges. As to the prices charged per message, they are presumably based upon what the telephone company thinks the public will stand and with little or no relation to the actual cost of the service. Entrenched as the company now is, the public will apparently have to continue to "stand and deliver" whatever this monopoly may demand, though its existence depends upon the grant of franchises by this selfsame public. The hope of relief from the Legislature past experience has demonstrated to by very remote, unless it should happen that sometime this body may contain a membership, a majority of whom will not be susceptible to the influences which so far, it is broadly hinted, have prevented any legislative action.

HYSTERESIS.

In another column Mr. C. P. Steinmetz very clearly shows the distinction which should be made between hysteresis, or magnetic lag, and molecular magnetic friction. These have been confounded by some writers, but it is shown that their values are only coincident and represented by the area of the hysteretic loop when the iron is neither receiving nor giving out energy externally. Dr. Duncan has shown that if a transformer is vibrated the magnetic lag is reduced, and Mr. Steinmetz states that in this case the loop may not only entirely collapse but even give a negative value, which is equivalent to a magnetic "advance" instead of "lag." On the other hand, if energy is expended, as when a transformer "hums," the area of the loop becomes greater by an amount corresponding to the energy thus used. The observation of Prof. Fessenden, in an article elsewhere in this issue, that the law of Steinmetz expressing the value of hysteresis has been shown to be only approximately true by the experiments of Prof. Ewing and Miss Klaassen may be just, but we are not aware that Mr. Steinmetz claimed that his formula expressed a law, and the same may be said of the expression of Mr. Kennelly for ferric reluctivity. We understand that both were put forth merely as formulas to express as nearly as they may the results of experiments, and not as the mathematical expression of a physical law. The expression found by Prof. Fessenden for the area of the hysteresis curve is interesting on account of furnishing another relation between the various quantities concerned. Every addition of this character, though it have no apparent practical value, yet adds another vantage point from which a phenomenon may be viewed, and thus increases the chance of at length determining its true physical significance.

COST OF ELECTRICITY.

In our issue of May 19 we referred editorially to some English data on the cost of generating electrical energy in central stations, from which the conclusion was drawn that six cents would probably more nearly represent, exclusive of capital charges, the cost per horse power hour of generating current in the central stations of this country than four cents, the figure usually quoted. In the valuable annual reports of the Massachusetts Board of Gas and Electric Light Commissioners, of which that for 1893 has just been issued, extensive official data and information are given of all the central stations in that State, and while not in a form to be directly applicable to calculations on the entire cost of generating current, yet they will enable approximate results to be arrived at. Almost all of the companies in the State do both arc and incandescent lighting, and some also supply current for motors, which renders it difficult to fix on a rate which will represent the average cost at which electrical energy is sold. The charge for incandescent lighting is almost uniformly one cent per 16-c. p. lamp hour, and it is probable that, as usual, where flat rates are given, they are based upon the same figure; assuming that the prices received for arc current are also based upon incandescent charges, we have twelve cents as the approximate price received per hourly horse power. This figure would be too high for motor rates, but as that assumed for arc light charges is probably too low in many instances on account of the "scaling down" of current for public arcs, we may assume twelve cents per hourly horse power as the average received for all electrical energy sold, which, however, will include carbons for arcs and trimming. In looking over the result of the operation of the various stations for the year ending June 30, 1893, we find that of 60 companies, 26 did not declare any dividend and six did not earn expenses. Of the 28 companies which paid dividends, 19 paid from 6 to 8 1-3 per cent., the remaining nine paying from 5 to 1 per cent. It will be thus seen that over half of the central stations of Massachusetts found no profit in operating, or, under our assumption, it cost them twelve cents or more to generate an electrical horse power. The stations which operated at a profit were the larger ones, and of these we have tabulated below the ten largest, arranged according to the plant investment, with the largest station first:

	Investment, per kilowatt.	Operating Expenses. Income from sales per cent.
1	$600	58
2	730	69
3	680	55
4	635	63
5	520	63
6	700	60
7	636	66
8	465	52
9	510	64
10	255	68
Average	573	61.8

Opposite to each in the first column is the cost of plant per kilowatt, obtained by dividing the investment in steam and electrical machinery, distributing system and real estate, by the maximum dynamo capacity, which data are given in the report. The second column contains the ratio of the operating expenses to the income from the sale of current, the former including management, and, apparently, maintenance repairs. The investment in plant is extremely high per kilowatt, and it would be interesting to know how much less any one of the stations could be built for at the present day. Assuming 60 per cent. as the average ratio of operating expenses, if the current was sold for twelve cents per horse power hour, the cost, exclusive of investment charges, would be 7.2 cents, or if sold at ten cents, would be six cents, which would seem to be as low a figure as should be used to base calculations upon.

India Rubber.

The "Madagascar News" of March 17 announces that a rubber concession has just been granted to the Hon. John L. Waller, ex-United States Consul for Madagascar. The concession area measures 15 miles square, in the district of Fort Dauphin, on the southeast coast, and is conceded to be one of the richest rubber districts in the island. The discovery of rubber in this district is of recent date, and the article is of excellent quality. Mr. Waller states that he will stop the destruction of the rubber trees and vines by the natives so far as his concession is concerned, and preserve the product by having the milk extracted in a scientific manner.—London Electrician.

Magnetic Friction and Hysteresis.

BY CHARLES PROTEUS STEINMETZ.

Friction is a universal phenomenon of nature. Wherever motion, molar and molecular, takes place, energy is consumed by friction and dissipated as heat.

Thus, when iron is alternately magnetized and demagnetized, in the cyclic motions of the molecules, which represent the change of magnetism, energy is consumed.

This energy of magnetic molecular friction is converted into heat; the iron gets hot.

Since in almost all electro-dynamic machinery periodic changes of magnetism in the iron take place, it is obvious that the consumption of energy by this change of magnetism, i. e., *the molecular magnetic friction*, is of the utmost importance as one of the fundamental factors determining the efficiency and the output of the apparatus. Thus, the predetermination of the molecular magnetic friction becomes necessary.

If a piece of iron is magnetized and demagnetized alternately, it has been found that during the rise of M. M. F. the magnetism is lower than during the decrease of M. M. F., so that during the rise of M. M. F. the same value of magnetism is reached at a higher M. M. F. than during the decrease.

This phenomenon is called *hysteresis*, i. e., magnetic lag.

Thus, if a piece of iron is exposed to alternating M. M. F., the magnetism, as function of the M. M. F., describes a closed curve, the loop of hysteresis.

The change of magnetism induces in the magnetizing circuit E. M. Fs., which consume energy, and it has been proven that the energy consumed by these E. M. Fs. is proportional to the area of the hysteretic loop. This loss of energy in the magnetizing circuit during the alternation of magnetism is called the loss of energy by hysteresis.

As seen, the loss of energy by hysteresis has directly no relation to the loss of energy by molecular magnetic friction.

But the energy consumed by magnetic friction must be furnished somewhere, and if no external source of energy is applied, the hysteresis furnishes the energy of molecular friction.

But even then the hysteretic loop need not be equal to the energy of the magnetic friction, but hysteresis may, besides molecular friction, furnish mechanical energy also.

Some cases may illustrate this.

In the alternating current transformer, energy is neither supplied to, nor expended by, the iron, except in the magnetizing circuit. Thus, in this case, the hysteretic loop equals the energy of magnetic friction, i. e., hysteretic energy and molecular magnetic friction are identical.

If, however, the iron pieces of the transformer are loose, so that they are set in vibration by the alternating field, the mechanical energy of vibration has to be furnished by hysteresis, and the hysteretic loop increases, representing now the sum of the energy consumed by molecular magnetic friction and by mechanical vibration.

On the other hand, if the iron of the transformer is set in violent vibration by an external mechanical force, a part of the energy of magnetic friction is supplied by mechanical power and not by the M. M. F., and thus the hysteretic loop collapses more or less, representing now only that part of the magnetic friction supplied by the M. M. F. In this case the loop may even become negative, that is, energy may be put into the electric circuit by the magnetic circuit as an electric generator.

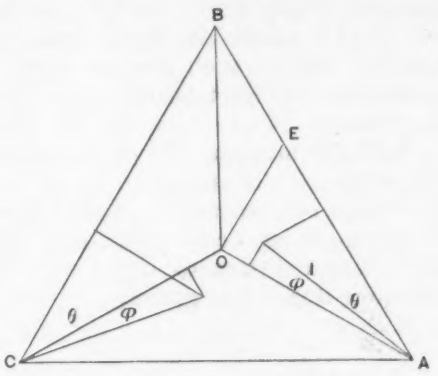
The conclusion from all this is that hysteresis can be used for measuring the energy consumed by molecular magnetic friction only, when care is taken to exclude any external source or expenditure of energy. But if external transformation of energy takes place, as in revolving machinery, no conclusion can be drawn from the hysteresis with regard to the magnetic friction, and especially *disappearance of hysteresis does not mean disappearance of molecular magnetic friction*, but means that the energy of magnetic friction is supplied from another source.

A Proof of the Two Wattmeter Method of Measuring a Three-Phase Current.

BY J. D. E. DUNCAN.

In testing a two-phase three phase transformer, built at Sibley College laboratory, according to the plans of Mr. Charles F. Scott, the two-wattmeter method was used for measuring the three-phase current. Thinking that it might be of interest to the reader a short proof is here given.

Consider the case of an equally balanced three-phase circuit as shown in the figure. Let $A\,O$, $B\,O$ and $C\,O$ be the



THREE-PHASE WATTMETER MEASUREMENTS.

lines which represent the E. M. Fs., the sum of the instantaneous values of which is zero. Let the currents be equal to each other and lag behind the E. M. Fs. by an angle, φ. Then by the ordinary method of measurement the power in each branch is equal to $E\,I\cos\varphi$, or the total power in the circuit is

$$W = 3\,A\,O\,I\cos\varphi.$$

If we use the two-wattmeter method with the wattmeters placed in circuits A and C, we will have the pressures represented by the lines AB and CB. Let the angle BAO be called θ. Then we will have the power in one wattmeter measured by $A\,B\,I\cos(\theta - \varphi)$ and in the other by $C\,B\,I\cos(\theta + \varphi)$, or the total power is

$$W = A\,B\,I\left\{\cos(\theta - \varphi) + \cos(\theta + \varphi)\right\}$$

since $A\,B$ is equal to $C\,B$. This by expansion becomes

$$W = 2\,A\,B\,I\cos\theta\cos\varphi.$$

But by similarity of triangles in the figure

$$A\,B = \frac{3}{2}\,A\,E,$$

also

$$A\,E = \frac{A\,O}{\cos},$$

whence

$$W = 3\,A\,O\,I\cos\varphi.$$

An analytical proof for a perfectly general case is too complicated to be followed out easily, but it has been shown graphically that this method is accurately correct for any three-phase currents, at any voltages, with any form of curves, so long as the sum of the instantaneous E. M. Fs. is zero, and the sum of the instantaneous currents is zero.

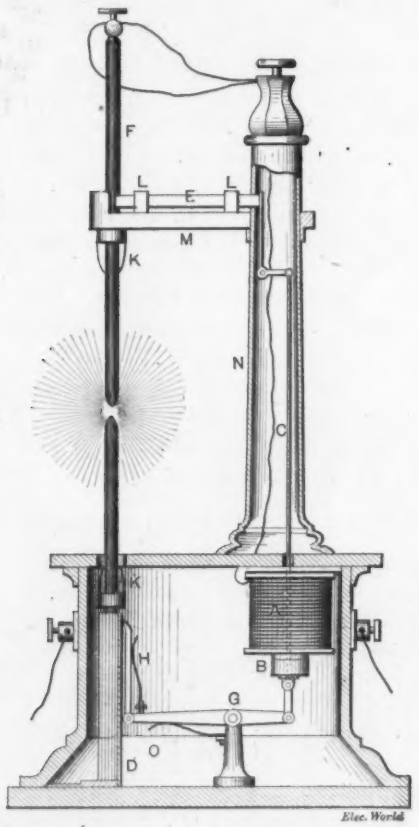
Wire Made of Ice.

In one of the recent lectures by Prof. Dewar, "On Solids and Liquids," he stated that under the pressure of 30 to 40 tons to the square inch ice behaves like a viscous solid and may be forced through a narrow orifice in the form of a fine wire.

An Early Arc Lamp.

We have received from Mr. Charles H. Fisk, of Detroit, Mich., a copy of the "Rural Intelligencer," published in Augusta, Me., and dated Jan. 27, 1855, and the following description of an arc lamp, taken from its columns, may be of interest, on account of the early date of the paper.

"We give below an engraving of an electric lamp, which we had the pleasure of seeing several times while in London. We have no faith in electricity as a motive power, either for decomposing water, propelling machinery, or furnishing light, for the obvious reason that no *force* is eliminated without a corresponding destruction of matter. And it is well known that six pounds of carbon (coal) are equal to 32 pounds of zinc for producing heat or other force, while in the one case we burn with air, which costs nothing, and in the other with sulphuric acid, which is and ever will be expensive. And in all probability coal will ever be much cheaper than zinc. While such are our views, we cannot but say that this electric light astonished every one by its brilliancy and power. It was exhibited one dark night on the Duke of York's monument, one of the highest places in London, from whence, it is said, it could *be distinctly perceived* at a distance of nine miles. The light was thrown on to a building on which we were standing, and though it was a quarter of a mile distant, we could see clearly to read. Such was the effect that it was gravely proposed to have an



AN EARLY ARC LAMP.

electric light and a vast reflector suspended over the city, and which it was confidently expected would furnish an artificial sun to turn night into day and render street lamps unnecessary. The following description will enable the reader to form a correct idea of the nature of the lamp:

"The electromagnet is at *A*, and its armature, *B*, which is beneath, is shown in contact, so that the brass rod, *C*, passing through the centre of the magnet, is in its elevated position. The rod thus—by means of the bell crank lever *D* bearing against the loose sliding bar, *E*—holds the main vertical sliding rod *F* in a fixed position. The armature, *B* is screwed on to the lower end of its link rod *C*, so as to admit of easy adjustment; and it is connected by a link on its lower side, with the shorter arm, of the double *G*, the opposite longer arm of which has a spring catch, *H*, jointed to it and arranged to work in the finely toothed sliding ratchet piece, *J*.

"The ratchet terminates, as also does the upper sliding rod *F* in a steel or platinum spring clip *K*. The loose overhead bar *E* works in small guide eyes, *L*, on the bracket *M*, and this bracket slides down with stiff friction upon the main pillar *N*. When from the consumption of the electrodes, the distance between their points is increased so much as to stop the current, the spring *O* draws down the armature *B*, and lifts the ratchet at the same time that the upper sliding rod *F* is released. The electrodes thus simultaneously approach each other, and the requisite distance being attained, the consequent instantaneous renewal of the current fixes them both by the upward jerk of the armature."

New Telephone Rates.

The Metropolitan Telephone and Telegraph Company announces the following schedule for exchange service and message rates, to take effect June 1, 1894, and apply to New York City south of 110th street:

Number of messages.	Two-party line.	Direct line.	Excess messages.
700	$100	...	$15 per 100
800	110	...	12 " "
900	120	...	12 " "
1,000	130	$150	12 " "
1,100	138	158	10 " "
1,200	146	166	10 " "
1,300	154	174	10 " "
1,400	161	181	9 " "
1,500	168	188	9 " "
1,600	175	195	9 " "
1,700	182	202	9 " "
1,800	188	208	8 " "
1,900	194	214	8 " "
2,000	200	220	8 " "

For more than 2,000 messages direct lines only will be used, and the rate of advance will be $5 per hundred, with $7 per hundred for excess messages. For these rates, lines will be metallic circuit and equipped with long distance transmitters (wall or desk sets only). For a cabinet set (wall or desk), $10 per annum additional will be charged. An installation charge of $15 will be made for each station. Where an established station is brought under a message rate contract the installation charge will not be made.

Simple Remedy for Trouble in a Telephone.

We have received the following communication from Mr. J. M. Kent, of Kansas City, Mo., describing how a trouble in a telephone was remedied in a very simple manner:

"A friend of mine in a neighboring establishment has a telephone containing three ordinary Bell receivers, which are used both as transmitters and receivers. They gave trouble constantly. One would be reported as 'not talking,' and he would take off the cap and find nothing wrong, would put the cap back again and it would work all right. Perhaps in an hour or so it would again refuse to act. This was kept up for several months. He tried varying the distance of the diaphragm from the magneto, and also examined the circuit time and again, but with no better success. One day we noticed that the edge of the orifice in the cap came very close to the diaphragm, and I suggested that perhaps a drop of saliva might lodge against the diaphragm and the edge of the orifice and impede vibration. This was found to be the case, and a ring of thick cardboard placed between the cap and the diaphragm remedied the trouble completely."

The Berliner Telephone Suit.

The Berliner telephone suit will come up for trial before the United States Circuit Court at Boston next week.

SWITZERLAND AS THE PRESENT ELECTRICAL CENTRE OF EUROPE

BY FREDERICK BATHURST.

Having seen the generating plant, it is necessary to return to the centre of the town to the distributing house, distant 1 1-2 miles, for three pairs of concentric cables convey all the current generated in the station to this point. This house is as near the lighting centre of the town as it is possible to place it. It is situated by the side of the river on the Rathhaus quay. A wooden construction 10 feet by 20 feet, with tiled roof, it resembles a small Swiss chalet, and no one, unless initiated, would imagine that such a

TRANSFORMER BOX.

quiet, unpretending looking structure represented the vital centre of the town lighting.

From here distributing cables radiate to each of the twelve sub-districts placed in the centre of their respective lighting fields. As new quarters of the town adopt electricity, other cables branch out for the purpose of conveying the needful current. When laying these distributing cables the ultimate wants of the district are anticipated as far as possible, so that the expense of relaying extra ones and the interruption of the town traffic, due to the opening of the trenches, are minimized, and the work is carried out without presenting a nuisance. To the larger centres it is found advantageous to lay two or three cables of moderate sectional area in preference to a single one of equivalent area; the smaller cables are more easily handled and can be made to assist the operator in keeping better regulation for the varying loads. Every high potential cable laid in the town has an end in this house, so that should a breakdown occur, they can be tested out and the fault located at once. Each cable has also double pole switches and safety fuses, these latter consisting of a 7-inch length of tin-alloy wire enclosed within a glass tube. The switches and fuses are neatly arranged on the opposite walls of the house, those for the outer conductors being on one side and those for the inner on the other. This makes it impossible to accidentally short circuit any cable and keeps exposed high potential terminals apart from one another. An ammeter shows the total amperes being used on the whole system, and test can be made for each sub-centre.

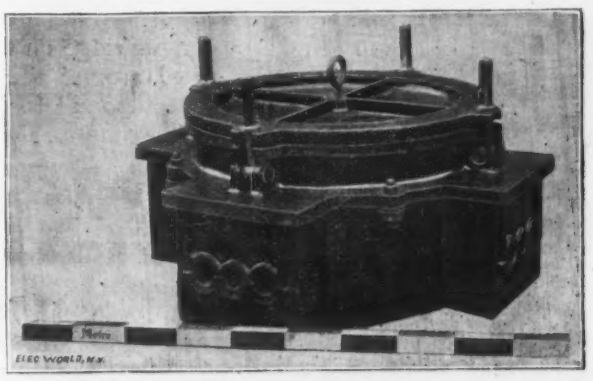
Volt lines return from each sub-centre to advise the attendant of the voltage at those points. A recording voltmeter shows the voltage fluctuation on the system, while records are kept of the current output by day and by night. A telephone in this house enables either the public or an employe to report immediately any trouble that occurs on the lines. The house itself serves as a sub-centre for the district immediately around it, while the farthest is distant some 1,700 yards.

The size of distributing cables is calculated upon the basis of 3 per cent. drop allowance for full load.

It is perhaps a transforming centre that takes one most by surprise and confirms the opinion already formed as to the high grade engineering ability displayed in the design of this installation. In all continental towns, as the European traveler knows, the local authorities exercise a strict supervision over the placing of advertisements; to the English or American mind, they would appear to act almost arbitrarily in their effort to have their town look well. The axiom of a "place for everything" becomes truly an aphorism and advertisements are kept in their "proper place." Upon the corners of the streets or in the centres of the squares the Kiosque de Publicite, or the Anzierger, is a conspicuous object that by those who are desirous can be readily scanned. In Zurich they are utilized as a thing of usefulness as well as beauty! They serve the double purpose of holding the flaming advertising poster and harboring the quiescent electric converters. The cut shows such a sub-centre of electrical distribution.

Within the sheet iron shell, an angle iron frame is built up, so as to form a series of racks or tiers, each tier serving to support a converter.

One standard size of converter—20,000 watts—is employed throughout, that number being placed, one above



CLOSED CABLE BOX.

the other, as will suffice to supply the district around the Anzierger, more being added as the district grows. There are 33 single converters placed in the 14 substations, so that each averages two, although some contain six or seven or eight converters. They transform from 2,000 volts to 200 volts, but the secondary coil has a centre connection so that 100 volts can be obtained and the dis-

tribution effected on a three-wire system, with 100 volts on each side. Marble connection boards, fitted on the side of the frame, serve to carry the terminal ends of the cables coming into the Anzierger and permit of all the primary coils being connected in parallel and the secondary connected to the three-wire bus bars.

Motors, arc lamps and incandescent lights are supplied from these centres, but in order to keep the system properly balanced a rule is made that any load over 1,800 watts must be taken from the outside wires of the secondary low pressure three-wire system. In this way no trouble is experienced in equalizing the load. Each Anzierger supplies current within a radius of 400 yards.

Zurich is a typical Swiss town as regards the extent of ground it covers, and, being built on two hills on opposite sides of a river and having in addition streets which are irregularly laid out, it presents even greater difficulties to the lighting engineer than the average American town. By this sub-station arrangement, current is economically distributed throughout the town over an area 2 miles by 2 1-2 miles, or say, 6 square miles.

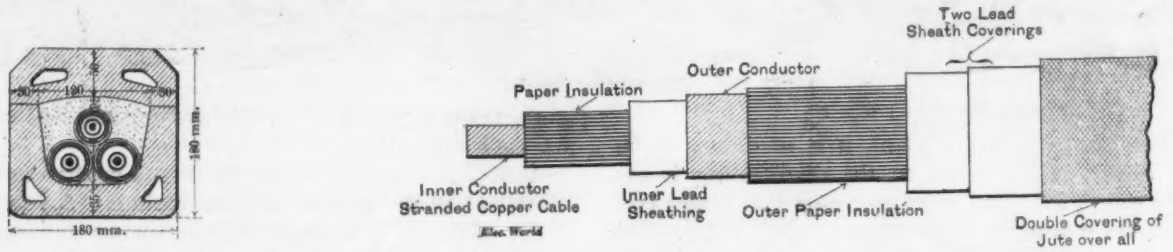
From the Anzierger cables pass out along the streets to be supplied to cable boxes (see cut). These boxes are of two kinds, "Offener Schact" and "Gedeckter Schact"—opened and closed. The closed boxes are generally used at the ends of the branch mains, or upon those lines which are either fully loaded or not likely to be disturbed. Open boxes are placed in lieu of manholes at the intersection of streets. They contain the safety fuses and permit the connecting in of additional mains for other streets. In order to lay down the network of mains with the least possible cost and to simplify examination in case of fuses blowing, as many as three blocks, or houses, are sometimes connected in one box, and where possible adjacent houses are fed from the same line, which passes through the cellars. A closed box is completely filled with compound, but the sealing up of the open box is remarkably simple and effective.

The top of the box is made watertight by means of a V groove filled with compound and a tongue ridge on the lid, while special partition pieces are fitted around the cable ends, so that they are surrounded by compound for about three inches of their length before passing out into the cable troughs. The service box for the inside of each house is a very neat and simple one, and is provided with three terminal projections, so that the house wiring can be connected on to either side or on the outer wires of the secondary system.

All the cables, where possible, are laid in stoneware troughs (see cut). These are strong, simple and cheap, and afford excellent mechanical protection to the cables. When the troughs are in position the cables are laid in the trench so formed and covered in with sand, which serves as an elastic cushion, upon which the stoneware cover can rest. No serious attempt is made to cement the trough lengths together, so as to obtain a watertight conduit, the ends merely being butted close together and "grouted" where necessary. A trough of this kind having a sectional area of 16 square inches costs about 25 cents per yard run.

A diagram of the concentric cable employed is shown. It has paper insulation and two lead sheaths, the outer copper conductor being stranded directly on to the inner lead sheath. The secondary system has three conductor concentric cables. Something like 300,000 feet of cable has been laid into 89,000 feet of trough; about two-thirds of the cable is in the secondary system.

At first some difficulty was experienced through induction effects in the town telephone system, but a simple and complete remedy was found for the trouble by making several good "ground" connections upon the outer lead sheaths of the electric light cables.



METHOD OF LAYING CABLES AND CONSTRUCTION OF CONCENTRIC CABLES.

The present output of the station is between 600 and 700 kw.; incandescent lamp circuits have been wired equivalent to 10,000 16-c. p. lamps.

The lamp finding most favor consumes 3.5 watts per candle, or, say, 60 watts per 16 c. p. It costs 26 cents and has a good life capacity. Experiments are being made with lamps having an efficiency of 2.5 watts per candle power, but these, so far, have not shown sufficient life capacity to merit their being adopted as standard.

Arc lamps to the number of 130 have been installed, 80 being used for the streets and railway station and 50 for commercial purposes. The former take 20 amperes and are rated as 1,600 c. p. nominal, the latter 10 amperes for 800 c. p. nominal.

ORNAMENTAL LAMP POST.

These lamps are run in circuits of six in series across the outside wires of the secondary system, that is, on 200 volts. When starting up they flicker slightly and take an increased current, but get down to steady work within a few minutes. Fig. 10 shows the elegant lamp post adopted for the street lighting.

In addition to the lighting by night a day load for power is being catered for and about 15 small alternating motors are at present installed. The largest motor is 2-h. p., the majority being 1-2-h. p. capacity. These all run synchronously and there is no trouble when starting them.

Nearly every lamp or motor is run on a meter basis, this method being preferred to a "contract" charge, and it is a eulogium to American electrical apparatus of no mean degree to find that nearly 300 Thomson meters are being used on the circuits.

Each 16-c. p. lamp is estimated to bring in a revenue of $5 per year, and making a calculation upon this basis, I estimate that a return of from 5 to 6 per cent. is being obtained on the capital invested in the plant. It is almost impossible to make a direct comparison of the cost of this and a similar American plant, but the following figures are interesting as showing the relative expenditures for the various portions of the plant: Approximate cost of dynamos, switchboard and connections in station, 300,000 francs; approximate cost of cables and conduits, 500,000 francs; approximate cost of transformers, sub-stations and arc lamps, 200,000 francs; approximate cost of turbine equipment (estimated), 100,000 francs; approximate cost of engine and boiler equipment (estimated), 180,000 francs.

If other testimony were needed as to the effective, substantial and workmanlike manner in which this plant has been installed throughout, it might perhaps be found in the fact that only one mishap of any sort has happened since the day current was first switched on. This accident, it is to be regretted, was fatal, but was entirely the fault of the sufferer, who disregarded instructions as to making connections when the current was on the mains. Except this, an electric service has been given, day in and day out, without fault, and to judge from the continual and increasing demand for current, the idea has instilled itself into the minds of the townspeople that electricity is absolutely indispensable to the welfare of this, their rising town, the commercial centre of Switzerland.

The Electrical Staff of the Midwinter Fair.

The accompanying illustration presents the electrical staff of the California Midwinter Exposition. It will doubtless be a surprise to many that so large a corps of men were required for this work, and this fact will serve to correct false impressions as to the magnitude of the Midwinter Fair. Chief Engineer W. F. C. Hasson, who is seated in the centre of the group, and his able assistants, deserve great credit for the successful execution of so great a task in the face of unusual difficulties, which would have discouraged less resolute men. The success of the Fair is in no small measure due to their exertions.

ELECTRICAL STAFF OF THE MIDWINTER FAIR.

Telegraph Dynamo in Postal Telegraph Office, San Francisco.

In the San Francisco office of the Postal Telegraph-Cable Company is a dynamo giving current for telegraphic purposes, which seems to be built on the lines that will be followed for future work of this character and generally where several small currents of various pressure are required. In the main office of the company, recently opened in New York, and in other places where dynamos are used for telegraphic purposes, a group of dynamos is used, the members of which are wound for different voltages and can be connected in different ways as required.

In this case, however, one dynamo having but one winding on the armature and fitted with an ordinary commutator is used to give several currents at the different electromotive forces required.

The method of doing this is, of course, obvious, as it is only necessary to put a series of brushes around the commutator, but the difficulty is that when such brushes are placed far from the line of commutation, the coil short circuited will momentarily have an enormous current flowing in it which will cause it to heat badly, and there will be a vicious spark when the short circuit is broken. The continuity of the current must not be broken, so short circuiting cannot be avoided by having the brush pass entirely off one bar before touching the next. In the machine under consideration the difficulty has been simply and effectively overcome in a manner clearly explained by the views given. The machine is a motor-dynamo, built by the Electrical Engineering Company, of San Francisco, after designs by Mr. F. P. Medina, electrician for the Postal Telegraph Company; the motor takes current from the lighting mains and drives the dynamo at 1,100 revolutions, the meter showing an average power taken of 310 watts per hour. The armatures of both motor and dynamo are elongated Gramme rings.

Insteady of the ordinary rocking brush holder, the views

show the dynamo fitted with a heavy brass ring, to which the brush holders can be clamped in any position. The view of the brush holder shows it to be a heavy brass casting, in which are three pieces of insulating material. The middle piece has two broad shallow channels cut in it, one on each side, which receive the two brushes shown. The brushes consist of two strips of copper sheet, making a total thickness of about 1-32 inch, and they can move freely in the grooves. When in place on the commutator they are pressed nearly to the face of the insulating material, the necessary pressure on the commutator being secured by the elasticity of the rubber bands, of which one is shown. The insulation between the commutator sections is considerably thicker than usual, so that, allowing for the springing or displacement of the ends of the brushes, it is impossible for one brush to touch two bars and thus short circuit them. Wires from the two brushes lead to two binding posts carried by the brush holder, and from these other wires complete the circuit through an ordinary 16-c. p. lamp; thus, when the two brushes are each on a bar, the circuit for that coil is complete through the high resistance lamp and no rush of current can take place, and there is absolutely no sparking at the commutator.

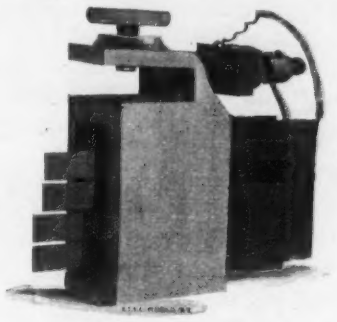
In the illustration three brush holders will be seen on the left and four on the right. The lower one of the four is grounded and the other six can be put to line, giving the positive and negative currents required. The grounded brush is placed at right angles to the diameter of commutation, and the others in any desired position, according to the pressure desired. Each brush taken in conjunction with the grounded brush makes a complete circuit, but the currents from the positive and negative brushes in part neutralize each other, so the grounded brush really passes but little current, acting like the third wire of a three-wire system. As at present arranged, the armature gives six currents, but it is obvious that as many as are desired may be taken, the only limit being the capacity of the commutator to receive brushes.

The dynamo is wound to give a maximum potential of 400 volts, and, as set, the upper brushes have negative potentials of 40, 125 and 180 volts.

Without the ground and for complete metallic circuits, obviously as many currents can be taken as combinations can be made of the six brushes.

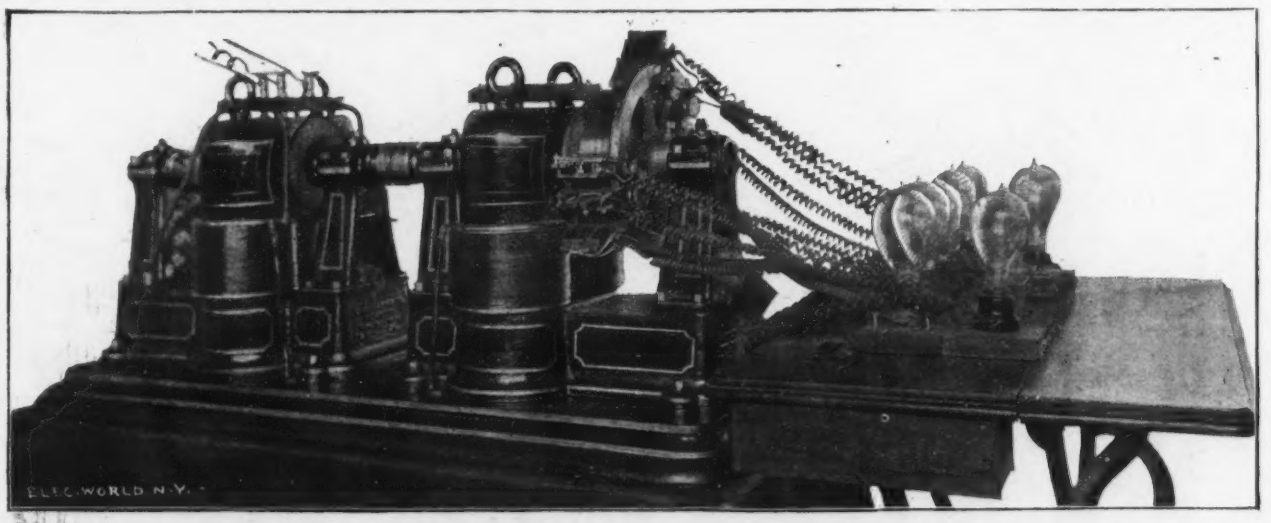
There are at present operated from this machine five city lines, varying in length from one to five miles, one quadruplex and four Morse wires, varying in length from 90 to 300 miles.

The plan of using a double brush with a resistance between the parts is not new, as it has been considerably used, especially where alternating currents are to be rectified for exciting purposes; also brushes have been made gradually increasing in resistance from the leading to the following



BRUSH HOLDER.

side, so as to lessen the effect of short circuiting, but this plan of arranging a group of brushes so as to make a multiple potential machine of an ordinary bipolar dynamo with single winding and commutator is novel.



TELEGRAPH DYNAMO AT SAN FRANCISCO.

A Formula for the Area of the Hysteresis Curve.

BY REGINALD A. FESSENDEN.

In a recent paper, Prof. Ewing and Miss Klaassen have shown that the law of Steinmetz—that the hysteresis is equal to $\eta \mathfrak{B}^{1.6}$, is only approximately correct. This result agrees with that obtained by two of the writer's students, Messrs. King and Kleppinger, at Purdue University, who published in June, 1893, a thesis upon that subject.

From their results it appeared that:

First—If the hysteresis be supposed to vary as some power of the inductivity, this power varies between the wide limits of 1.5 and 1.8.

Second—That the curve of variation of hysteresis with inductivity does not show any simple relation, such as is given by Mr. Steinmetz, but is a much more complicated function.

These experiments were made upon the brands of sheet iron used by the principal makers of transformers in America, including the Thomson-Houston, Stanley and Westinghouse companies.

In view, therefore, of the fact that Prof. Ewing's results for the English irons give a similar result, it appears probable that Mr. Steinmetz's law, extremely valuable as it will always be as a means of making calculations where a moderate degree of accuracy is required, and where the exponent of $\mathfrak{B}$ for the particular iron used has been previously determined, is not an exact one.

The publication of a simple relation noticed by the writer last summer may be of interest. Publication has been delayed in order that the subject might be more thoroughly investigated. As, however, a very careful checking of the results has shown that it holds, at least for all the different kinds of iron used by transformer manufacturers in this country, to within 1-2 per cent., it is given here. Even if it should prove not to hold for cast and other hard irons, it may still be of use. The subject is at present being further investigated by two of the students of this university, but the final results will not be published for some time.

The law of Kennelly, as is well known, is that the ferric

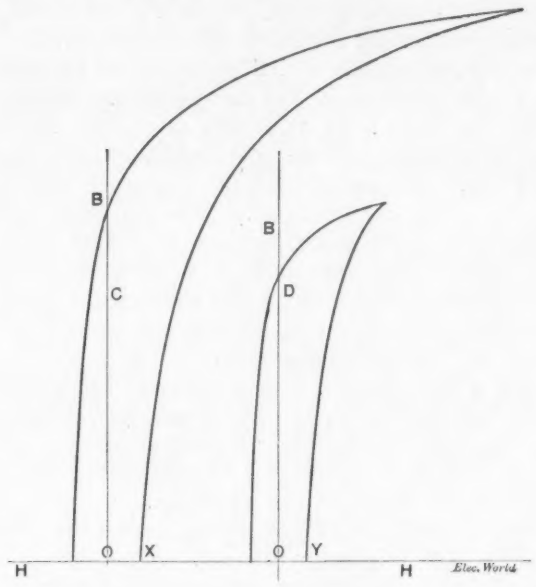


FIG. 1.

reluctivity is a linear function of the intensity of the magnetizing force,) such that $\lambda = a + b\,\mathfrak{H}$. Experiments made by the writer and others have confirmed Mr. Kennelly's results, and show that the law holds within the limits of experimental error, except for small values of $\mathfrak{H}$.

The relation noticed by the writer is, that if on an ordinary hysteresis curve we take, instead of $\mathfrak{H}$, $\mathfrak{H} - b$ (where b is the coercive force), then what we may call the hysteresis

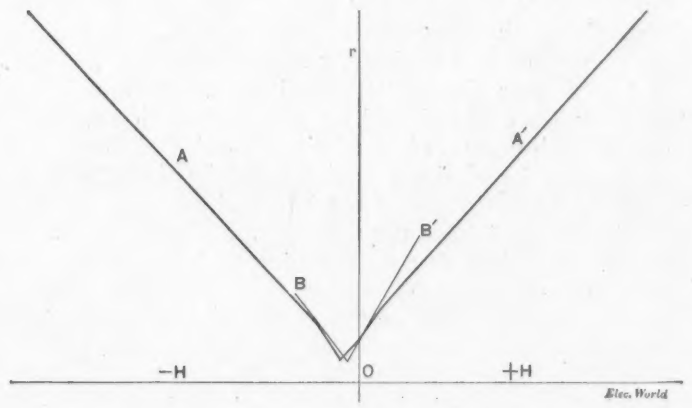


FIG. 2.

reluctivity will be given by $(\mathfrak{H} - b) / \mathfrak{B}$, as distinguished from the ordinary reluctivity, $\mathfrak{H}/\mathfrak{B}$, and if different values of this hysteresis reluctivity be plotted as ordinates, and the corresponding values of $\mathfrak{H} - b$ as abscissae, a straight line will be obtained, but one which does not pass through the origin. Therefore, the hysteresis reluctivity is a function of $\mathfrak{H} - b$, such that $C(\mathfrak{H} - b) + c = r$; or $r = C(\mathfrak{H} - a)$; where r is the hysteresis reluctivity, and a, b, c and C are constants.

It follows from this that for the up curve

$$B = \frac{\mathfrak{H} - b}{C\,(\mathfrak{H} + a)}.$$

By taking $\mathfrak{H} + b$ instead of $\mathfrak{H}$ for the down curve, or for the curve from maximum positive to zero induction, we get a similar relation, or

$$B' = \frac{\mathfrak{H} - b}{C'\,(\mathfrak{H} + a')}.$$

In Fig. 2, A and A', B and B' show the lines got by plotting $\mathfrak{H} - b$ as abscissae (where $b = OX$, Fig. 1) and $(\mathfrak{H} - b) / \mathfrak{B}$ as ordinates to get the right limb of C, and $\mathfrak{H} + b$ for abcissae and $(\mathfrak{H} + b) / \mathfrak{B}$ as ordinates to get the left limb. Similarly, by plotting $\mathfrak{H} \pm OY$ for $\mathfrak{H}$ we get the limbs of curve D. If more curves were shown they would overlap each other so closely as to be indistinguishable from one another.

It will be noticed that the lines are straight, to within one-half of 1 per cent., except near the origin, where they come slightly out of true. This is due to two reasons: First, owing to the shape of the hysteresis curve, a mistake of 1-4 per cent in the determination of the value of $\mathfrak{H}$ at points near the origin makes a difference of several per cent. in the ratio; second, there is a real departure from a straight line, because the iron is passing from one limb to the other, and as the two limbs of the hysteresis curve cannot have a common tangent at the point of intersection with the line of zero $\mathfrak{B}$, they would meet at a definite angle but for the fact that such physical changes, where a large number of molecules are concerned, cannot take place abruptly, but must shade off into one another. In doing this there is a mutual compromise, and both limbs of the reluctivity curve depart from a straight line near the origin.

These curves were made on a number of varieties of sheet iron, and in no case was the departure from the formula more than the limits of probable error, except, as mentioned, near the origin.

By integrating the area between the two limbs we get an expression for the total area of the hysteresis curve. It is

$$\mathfrak{H} = \frac{1}{4\,\pi\,C'}\left[\mathfrak{H} - (a' - b)\log\,(\mathfrak{H} + a')\right] - \frac{1}{4\,\pi\,C}\left[\mathfrak{H} - (a + b)\log\,(\mathfrak{H} + a).\right]$$

For the voltage in a transformer, when the induction is changing in a positive direction from zero, we have

$$d\mathfrak{B} / dt = \frac{(b + a)\,A\,\omega\cos\,\omega t}{(A\sin\,\omega t - b)^2} \text{ or } \frac{d}{dt}\left(\frac{1}{C\sin\,\omega t - d}\right).$$

These formulae are at present too complicated for practical use.

It will be seen that all of the properties of the iron are defined by five constants. One of the objects of the investigation at present under way in the hands of Messrs. Neubert and Parkinson is the determination of some possible relation between these constants by which their number may be reduced.

For the present, therefore, the writer only feels justified in saying that the relation mentioned above holds for the better kinds of sheet iron used for transformers to within 1-2 per cent and for values of $\mathfrak{B}$ less than 16,000.

It may also be of interest to mention that neither in the work of Messrs. King and Kleppinger, nor in that of the author, was any instance found where the maximum point of a hysteresis curve fell outside the ascending limb of the next larger hysteresis curve, which striking peculiarity was noticed in a number of instances by Prof. Ewing and Miss Klaassen. As mentioned above, however, these experiments were made upon a small number of kinds of iron only, i. e., only soft transformer irons.

These observations were made by the "step-by-step" method. No difficulty was found, when proper precautions

were taken, in getting the curves to close up to within one-fourth of 1 per cent.

It should be mentioned that the lines drawn in Fig. 2 were not drawn by smoothing the hysteresis curve, but taken directly from the results of the test. Even when the hysteresis curve is drawn so that its total height is 8 or 10 inches, one obtains more concordant results by taking the original observations than by attempting to draw a hysteresis curve, and then taking the observations from the curve so drawn.

In the formulae given above, the ferric inductivity has been taken as equal to the total inductivity, therefore also $(\mathfrak{H} - b) / \mathfrak{B}$ has been written for $(\mathfrak{H} - b) / (\mathfrak{B} - \mathfrak{H})$. This is sufficiently correct for all cases ordinarily met with in practice, but where the inductivity is very great, the correct formula must be used.

Western University of Pennsylvania.

The Design and Construction of Power Stations.*

In the design and construction of a power station the first thing to be considered is the location. The most natural place for this is at the centre of distribution, so that the fall of potential in the lines as well as the amount of copper shall be a minimum. But other things must be considered which have a very great influence upon this position, viz., cost of the land, which is usually great at this centre; availability of coal, and, in case of a condensing engine, the water necessary for condensation. The amount of space required per horse power depends upon the size of the plant. For an output of 100 h. p., 22 square feet per horse power is necessary, this amount decreasing as the output increases, until in plants of 2,000 h. p. the space per horse power becomes 9.5 square feet. The space does not decrease appreciably with further increase of horse power. If water power is unavailable for running the generators direct, it is desirable that the station be near a railroad to minimize the cost of hauling coal, and, also, since a city water supply cannot be depended upon for condensing purposes, it is essential that the station be in proximity to a stream or a body of water. That which saves in the cost of the energy is a saving every day, so that it may be better economy to locate the station somewhat removed from the centre of distribution, although the first cost of the copper required is much greater.

After the location is decided upon, the next question to be considered is the building itself, which, in consequence of the very costly machinery placed therein, must afford the very best protection possible. In the first place, it must be fireproof, and therefore constructed of brick and iron, and in the second place it must not allow the condensation of moisture on the interior, which is liable to injure the machinery. To avoid this, the building must be provided with a double roof of slate or tile, enclosing an air space whose temperature will be intermediate between that inside and outside the building. The moisture that condenses on the interior surface of the exterior roof is carried off by the interior roof, and in consequence of the greater equality of temperature of the air space and the interior of the building, very little sweating will occur on the inner roof. The engineer is concerned only with the general principles of construction, the details being left to the architect. The estimated cost of such a building is about $40 per horse power for 100-h. p. plants, and is redueed to $17 per horse power for plants of 2,000 h. p. and upward.

The size of the power house, and consequently the above estimated cost, depend largely upon the type of the generating system adopted. And then again, the type of the system depends considerably upon the size of the plant. The method of belting high speed engines directly to small units gives low economy and requires much space, and hence should be adopted only for small plants, or where a division to a small unit is necessary. Moreover, the large number of small generators requires extra attendance, and involves greater expense for commutators, brushes, etc. For large plants, it is much better to adopt a large unit with a condensing engine belted to a jack-shaft, or a low speed engine connected directly to a large unit. At present the engineer can rely upon manufacturers to fulfill the latter condition, and as a consequence, this method is rapidly coming into favor, since it obviates the necessity of belts and jack-shafts. Of course the unit should not be much larger than the minimum working load, for otherwise a waste of energy occurs whenever the load falls to the minimum.

The kind of engine which seems to be the best for railroad power stations is the compound condensing engine. The Corliss type is rated to run at quarter stroke, can be run at half stroke, can be overloaded, and is economical at light loads. The capacity of the engine should be from 20 to 25 h. p. per car operated. This will give sufficient reserve power, as the actual amount used varies per car from 15 to 18 h. p. and rises to 20 h. p. on steep grades. The cost of the complete steam plant varies from $45 to $55 per horse power for high speed engine, and from $65 to $75 per horse power for the Corliss type.

Until quite recently, it was thought impossible to construct large generators to run when coupled directly to engines of low speed, without increasing the weight per horse power of the generator to compensate for the necessarily reduced speed of the armature. But the Intramural Railway of the World's Fair demonstrates the possibility of this in a very emphatic manner. Although it cannot be accomplished by increasing the magnetic density of a bipolar machine, on account of the limit of the number of lines of force per square centimetre which iron will carry (about 14,000 to 15,000), it can be attained by increasing the number of poles, by placing the armature conductors in grooves, thus obviating the necessity of binding wires, and by using ribbons for end connections instead of the cylindrical conductor which cannot be so compactly laid and whose insulation is liable to disintegration at the points where the wires cross. The air gap should not be cut down too much for three reasons: With a very small air space the excitation is too low to maintain a stiff field at full load; Foucault currents become troublesome; and a great difficulty arises in maintaining the armature exactly centred, which is much more essential in a multipolar than in a bipolar machine.

A generator should be placed on a firm foundation of solid masonry and should be so constructed that its fields can be easily removed to admit of repairs of the armature. A dynamo for a power station must be thoroughly automatic, not only in theory but in actual practice, and should not be accepted from the manufacturers unless it proves to be so. Machines that do not give an increase of pressure proportional to increase in load work very badly when connected together. The cost of the generating system, including switchboards, is $35 to $40 per horse power.

The last thing to be considered, although by no means the least in importance, is the switchboard and its appurtenances. This should be constructed of non-combustible material. Slate or marble may be used, although neither is entirely free from disintegration when subjected to the heat from an arc that will occasionally be formed across its surface. All connections should be made at the back of the board, which should be large enough to admit of an increased number of connections as the plant grows. There must be a rheostat, voltmeter, and dead beat ammeter for each generator, a good, simple and reliable circuit breaker which will act at the point at which it is set, and likewise a lightning arrester which can be depended upon. Too much care

* Notes on a lecture delivered by Prof. H. J. Ryan before the Electrical Society of Cornell University.

cannot be exercised in the design of the switchboard and accessories, for it is an all important part of a station. Circuit breakers are preferable to fuses in that the fuse requires a finite amount of time to "blow," and, in the meanwhile, the powerful current is doing its damage in the armature; while with the circuit breaker the circuit is broken the very instant the current exceeds that to which the trip has been set. Another essential feature of the switchboard is the equalizing bar, which places the series coils of all the machines in parallel with each other and thereby prevents a generator, whose potential for some reason falls off, from being run as a motor—a condition of affairs which soon seriously injures the machine.

On the Measurement of the Power of Polyphased Currents.

BY ALEXANDER D. LUNT.

Polyphased currents are undeniably of great interest and value, as shown by the labor and attention bestowed upon the subject, both in theory and by practical application of the same. Considering the peculiar charm and attraction in the study of such currents, it would indeed be strange were it otherwise. Comparatively little attention, however, appears to have been paid to the methods to be followed in measuring the energy of currents of this nature, and so far as the writer is aware, the only available information on this point is to be found in a small number of contributions to several French and German periodicals, together with a few fragmentary transcriptions into English. Hence, the subject of the measurement of the power of polyphased currents, while not inherently difficult, is perhaps unfamiliar, and it may therefore not be devoid of interest or value to present a new and simple derivation of formulae applicable thereto.

In the practical application of polyphased currents the so-called two-phased and three-phased currents have found a place. But it is unlikely that currents of a higher number of phases will be used in the future, since the advantages of a larger number of phases may be obtained, if desired, by special systems of winding and connecting. For instance, the equivalent of a six-phased current may be obtained in a three-phased system by passing each current through two oppositely wound coils.

Consequently, it has been found of advantage to extend the following equations so as to include specifically any system having more than three main conductors or supply wires. It is perfectly obvious, however, as will be seen later, that currents of any number of phases may be comprehended in the equations by a mere addition of similar terms, so that the equations given are quite as general, so far as principles are concerned, as though they covered any polyphased system whatever.

Any discussion of the properties of polyphased currents is of course beyond the scope of this article, but in so far as it may bear on the subject of power measurement, it is not out of place to consider such principles as form the groundwork of results to be deduced therefrom.

A polyphased current, so-called, may be defined as a system of simple alternating currents of the same period chained together or superposed upon one another in such a manner that the respective currents are shifted in phase one behind the other, according to some known and generally simple law.

If a ring armature with n equidistant spaced coils be revolved in a uniform field of force, then the sum of the E. M. Fs. of the n coils will be

$$\Sigma\,\varepsilon = A\left[\sin\theta + \sin\left(\theta + \frac{2\,\pi}{n}\right) + \ldots + \sin\left(\theta + \frac{n-1}{n}\,2\,\pi\right)\right]$$

where A is a constant depending on speed of rotation, dimensions of coils, intensity of field, etc., and θ the angular distance of coil l from the neutral line.

It follows easily that

$$\Sigma\,\varepsilon = 0.$$

But as this conclusion depends on various assumptions, it is consequently only approximately approached in practice.

It is customary to show in the same manner that

$$\Sigma\,i = \frac{A}{\text{Impedance}}\left[\sin(\theta-\varphi) + \sin\left(\theta-\varphi+\frac{2\,\pi}{n}\right) + \ldots + \sin\left(\theta-\varphi+\frac{n-1}{n}\,2\,\pi\right)\right]$$

where φ equals the angle of lag of each of the currents i in the line wires. By a combination of analytical and geometrical methods it can easily be shown that this expression like the one above becomes zero whatever be the value of n and whether φ be positive or negative.

But this conventional manner of demonstrating the continuity of polyphased currents is seriously lacking in generality, and hence it might be concluded that the principle of continuity is of limited application with respect to such currents. Such is, however, far from being the fact, as will be readily seen from the following.

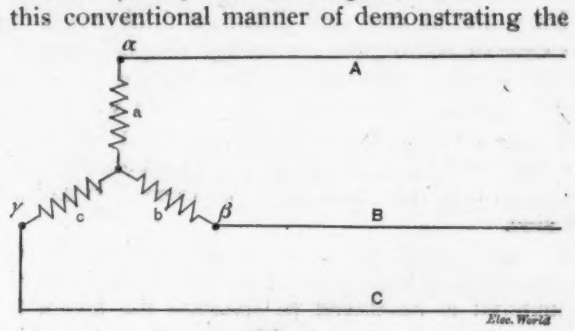


FIG. 1.

In the linear conductor carrying current it is self-evident that at any instant the current leaving any point in that conductor is the same in value as that which arrives at the point, and since the current arriving at the point is to be considered of opposite sign from that which leaves the point it of course follows that the algebraic sum of the said currents is zero. Uncertainty as to this fact at one time existed, owing to the erroneous supposition that dynamic electricity accumulated on the surface of conductors. If the point selected were the junction of several currents it would still be evident that as much current must arrive at the point as departs from it. Starting with this fact as a basis, it is apparent that the algebraic sum of the line wire currents of a polyphased current of the "star" form (Fig. 1) is zero at any instant. This fact while equally correct in the case of currents of the "mesh" form (Fig. 2) is possibly not quite so obvious, but will, however, be made clear by a simple consideration. It is evident that the sum of the currents at each junction in such a system is zero at any instant, and hence, referring to Fig. 2 for illustration of a simple case, we may write

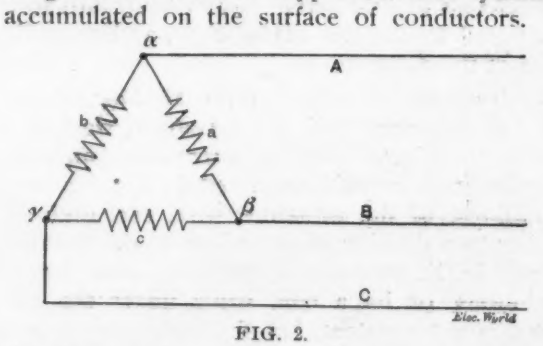


FIG. 2.

$$\begin{aligned} \pm a \mp c &= C, \\ \pm b \mp a &= A, \\ \pm c \mp b &= B, \end{aligned}$$

whence $A + B + C = 0.$

(To be continued.)

Practical Notes on Dynamo Calculation—IV.*

BY ALFRED E. WIENER.

10.—*Armature Insulations.*

According to the size and the voltage of a dynamo the thicknesses of the insulations in its armature vary in very wide limits.

The coating of the armature conductor, if single wire is employed, usually is effected by a double cotton covering ranging in diametrical thickness from .012 to .020 inch, according to the size of the wire and the voltage. If stranded cable is used for winding the armature, either bare or single cotton covered wire is used to make up the cable, and the whole is covered with two or three layers of cotton. The thickness of the single cotton insulation in this case varies from .005 to .010 inch in diameter. For very thin wires, from No. 20 B. W. G. (.035 inch) down, a double silk covering from .004 to .005 inch diametral thickness is applied.

In case of rectangular or wedge shaped conductors, according to their size and to the voltage of the machine, either a double cotton covering, as with wires, is used, or oiled paper, cardboard, asbestos, or mica is employed for their enwrapping or separation. The thickness of the insulation in the latter case varies between .010 and .020 inch, each side.

Besides this coating of the single conductors, sometimes —particularly in high voltage machines—a sheet of insulating material is employed to separate the layers from one another. The thickness of this insulation, for which either oiled paper, rubber tape or silk is used, ranges from .007 to .030 inch.

The insulation of the conductors from the iron body in smooth armatures is effected by serving the core with one or two coatings of enamel or japan and then covering it by either oiled paper, cardboard, canvas, silk, tape, sheet rubber, cotton cloth, asbestos, or mica, varying in radial thickness between .012 and 3-16 inch.

For toothed and perforated armatures this core insulation is carried out in form of paper, or cardboard, or vulcanized fibre tubes or channels, fitted into the grooves, or —especially in large toothed core machines—by means of mica troughs lining the bottom and the sides of the slots. The thickness of this lining ranges from .010 to .125 inch, proportional to the size of the slots, and according to the voltage of the dynamo.

11.—*Arrangement of Armature Winding.*

By "arrangement" of the armature winding is understood the grouping of the conductors into a number of armature coils, each containing a certain number of turns, or convolutions, of the armature wire, and each one corresponding to a division of the collector or commutator.

The E. M. F. generated by the combination of a series of convolutions, or by a coil, while under the commutator brushes, is not constant, but fluctuates with the rate of its cutting lines of force in the different positions during that period. This fluctuation of the E. M. F. of a dynamo, consequently, increases with the angle which is embraced by each coil of the armature, and can be mathematically determined from the measure of this angle. In a 10-coil armature, for instance, the angle embraced by each coil is 36 degrees, and the fluctuations of the E. M. F. are calculated to amount to $\pm$ 2.4 per cent. of the total E. M. F. generated. With a 12-division commutator the angle enclosed by each armature coil is 30 degrees and the fluctuations figure to $\pm$ 1.7 per cent. For an 18-bar commutator, the coil angle is 20 degrees, and the fluctuations are found to be reduced to $\pm$ 1 per cent. For 24 divisions in the commutator, the angle is 15 degrees, to which correspond fluctuations in the amount of about $\pm$ $^1/_2$ of one per cent. With 36 bars the angle is 10 degrees, and the fluctuations $\pm$ $^1/_5$ of one per cent. For 48 divisions the angle is 7 1-2 degrees, and the fluctuations $\pm$ $^1/_{10}$ of one per cent. For 90 divisions, the angle is 4 degrees, and the fluctuations $\pm$ $^3/_{100}$ of one per cent. With a 360-division commutator, finally, the angle enclosed by each coil is one degree, and the fluctuations of the E. M. F. reduced to but $^3/_{1000}$ of one per cent.

From these figures it is apparent that the fluctuations become practically insignificant, or the potential of the machine practically steady, if, for bipolar dynamos, armature coils of an angular breadth of less than 10 degrees, or, what amounts to the same thing, if commutators with from 36 divisions upward are used. For low potential machines—up to 300 volts—it has been found good practice to provide, per pair of poles, between 40 and 60 divisions in the commutator.

For high potential dynamos the voltage itself determines the number of commutator bars. For, in these, the self-induction set up in the separate coils, and the sparking at the commutator caused by the potential of this self-induction between two adjacent commutator divisions, are more important considerations than the fluctuation of the E. M. F.

No potential below 20 volts is able to maintain an arc across even the slightest distance between two copper points. The potentials above this figure necessary to carry an arc over a certain distance depend upon the intensity of the current. In order to maintain, between two copper conductors, an arc of .040 inch length—the usual thickness of the commutator insulation for high voltage machines—according to actual experiments made by the author, imitating as nearly as possible the conditions of a commutator, a current of

100	amperes	takes	20	volts
50	"	"	21	"
20	"	"	23	"
10	"	"	25	"
5	"	"	30	"
2	"	"	40	"
1	"	"	50	"

From this it can be concluded that, in order to prevent the commutator of a high voltage machine from becoming unnecessarily expensive, allowances have to be made as follows:

TABLE XVI.—DIFFERENCES OF POTENTIAL BETWEEN COMMUTATOR DIVISIONS.

Current intensity per pole.	Difference of potential between commutator divisions.
Over 100 amperes	10 to 20 volts
100 to 50 "	12 " 21 "
50 " 20 "	15 " 23 "
20 " 10 "	20 " 25 "
10 " 5 "	25 " 30 "
5 " 2 "	30 " 40 "
2 " 1 "	35 " 50 "

The respective minimum numbers of commutator divisions, consequently, are:

$$\left.\begin{aligned}
\text{For over 100 A. p. Pole . . } n_{min} &= \frac{E \times 2P}{20} = \frac{E \times P}{10} \\
\text{For 100 to 50 A. p. Pole . . } &= \frac{E \times 2P}{21} = \frac{E \times P}{10.5} \\
\text{For 50 to 20 A. p. Pole . . } &= \frac{E \times 2P}{23} = \frac{E \times P}{11.5} \\
\text{For 20 to 10 A. p. Pole . . } &= \frac{E \times 2P}{25} = \frac{E \times P}{12.5} \\
\text{For 10 to 5 A. p. Pole . . } &= \frac{E \times 2P}{30} = \frac{E \times P}{15} \\
\text{For 5 to 2 A. p. Pole . . } &= \frac{E \times 2P}{40} = \frac{E \times P}{20} \\
\text{For 2 to 1 A. p. Pole . . } &= \frac{E \times 2P}{50} = \frac{E \times P}{25}
\end{aligned}\right\} \quad (15)$$

Having thus determined the minimum number of divis-

* The following typographical errors occurred in the section of this article published in these columns last week: Page 740, second column, seventh line from top, "In the average values . . ." should read, "In Table III. the average values. . . ." In Fig. 1, page 740, the expression for the pitch of the slots should be $\frac{d_a' \times \pi}{n'}$, instead of $\frac{d_a \times h}{n'}$; for the width of the slot, in Figs. 1 and 3, pages 740 and 741, the letter s should be used instead of S; in Fig. 2, page 741, the diameter of the hole should be designated by δ_a' instead of δ_a.

ions that can be used in the commutator without excessive sparking, the actual number, n, to be employed has to be chosen by comparing this value of n_{min} with the total number of conductors on the armature, found by multiplying the rounded result of equation (8), (9), or (10), respectively, with that of formula (11), and dividing the product by the number, p, of armature wires stranded in parallel.

The number of turns, m, of armature conductors per commutator division, or the number of convolutions in each armature coil, is then readily obtained by dividing the total number of armature convolutions by the number of coils, n. The number of armature convolutions, in ring armatures, is identical with the number of armature conductors, while in drum armatures it takes two conductors to make one turn, and, therefore, the number of turns is but one-half the number of conductors. Hence we have:

For ring armatures:

$$m = \frac{o \times u}{n \times p}, \qquad (16)$$

and for drum armatures, or drum wound ring armatures:

$$m = \frac{o \times u}{\times \; n \times p}. \qquad (17)$$

If the armature is to have spacing strips, or driving horns, the number of the armature divisions for this purpose depends upon the number of armature coils, n, the number of turns per coil, m, and the number of conductors in parallel, p.

In ordinary machines the number of armature divisions is usually made equal to the number of coils, n, and sometimes—especially in drum armatures—double the number of coils, $2\,n$, is taken. For high current output machines often a greater number of armature divisions than that given by the number of coils is chosen. In such a case the total number of single wires, or cables, $m \times n \times p$, is to be suitably arranged in groups. The number of these groups is to be a multiple of the number of coils, n, and since the number of turns per coil, m, in high current dynamos, is usually $= 1$, the problem of grouping, in this case, amounts to sub-dividing the number of parallel wires, p.

12.—*Radial Depth of Armature Core. Density of Magnetic Lines in Armature Body.*

Diameter and length of the armature core being determined, its proper radial depth can be readily found by the cross-section to be provided for the passage of the magnetic lines of force.

The density of lines permitted per unit area of armature cross-section is limited by the heating of the armature due to hysteresis and eddy current losses. The heat, generated by either of these causes, increases with the density of the lines, and with the number of magnetic reversals per second. The latter number is the product of the number of revolutions per second and the number of magnet poles, and therefore it is obvious that, in order to keep the temperature increase of the armature in its practical limits, in dynamos where this product is great, larger specific sectional areas of the armature core are to be allowed than in machines having a small number of magnetic reversals, or a low "frequency," as half the number of reversals, or the number of complete magnetic "cycles," is called. The former—high frequency—is the case for high speed and multipolar dynamos, the latter—low frequency—for slow speed and bipolar ones. On the other hand, large multipolar machines generally have well ventilated ring armatures, and in these an even considerably larger amount of heat generated will produce a smaller temperature increase than in drum armatures of equal output.

According to these considerations, the following values of the densities of lines of force in the armature core are recommended:

TABLE XVII.—CORE DENSITIES FOR VARIOUS KINDS OF ARMATURES.

Kind of armature.	Density of lines of force. per square inch.	(Gausses.)
Slow speed bipolar drum	50,000 to 80,000	8,000 to 12,500
" " " ring	80,000 " 120,000	12,500 " 18,500
High " " drum	40,000 " 70,000	6,000 " 11,000
" " " ring	60,000 " 90,000	9,000 " 14,000
Slow " multipolar drum	30,000 " 60,000	4,500 " 9,000
" " " ring	50,000 " 80,000	8,000 " 12,500
High " " drum	25,000 " 50,000	4,000 " 8,000
" " " ring	40,000 " 70,000	6,000 " 11,000

The cross-section of the magnetic circuit in the armature core is the product of the net length, and the net radial depth of the core, and of the number of poles; and this product, divided into the total magnetic flux through the armatures, gives the density of lines per unit area. In order to obtain the net radial depth, or breadth of the cross-section of any armature core, therefore, the total armature flux is to be divided by the product of the armature density, of the net length of the body, and of the number of poles:

$$b_a = \frac{\Phi}{2\,P \times \mathfrak{B}_a \times l_a \times k_1}. \qquad (18)$$

The symbols used in this formula denote:

b_a = radial depth, or breadth of cross-section of armature core, in inches;

Φ = useful flux, in webers, or number of useful lines of force cutting armature conductors, the calculation of which will be the subject of a subsequent chapter (Part II., chap. 1); for determining the radial depth of toothed and of perforated armatures, this is to be multiplied by the factor of core-leakage (see Table XI., chap. 8);

$\mathfrak{B}_a$ = density of magnetic lines in armature body, in lines of force per square inch, given in Table XVII.;

P = number of pairs of magnet poles;

l_a = length of armature core, in inches, from formula (12);

k_1 = ratio of net iron section to total cross-section of armature core, see Table XVIII.

The constant k_1 depends upon the material, and the manner of building up, of the armature core. In order to prevent excessive losses and resulting heating of the armature due to eddy currents in the iron, it is necessary to laminate the body perpendicular to the direction of the active armature conductors. In case the active pole faces embrace either the outer, or the inner, or both circumferences of the armature, the active conductors are those parallel to the shaft, and the lamination of the core is to be effected perpendicularly to the shaft; while in case of the poles being at the sides of the armature (flat ring type), the active conductors run perpendicular to the shaft, and the lamination is to take place parallel to the shaft. In case of the pole pieces embracing three sides of the armature section, finally, the active conductors are partly parallel and partly perpendicular to the shaft, and the lamination, in consequence, is also to be carried out in both directions. The materials for effecting these various laminations are iron *discs*, iron *ribbon* and iron *wire*, respectively. The insulation of these laminae, in the majority of machines, has been, and is yet, effected by inserting sheets of thin paper, asbestos, etc., between them, although it has been repeatedly shown by practical experiments* that such an insulation is not only entirely unnecessary, but, on the contrary, even disadvantageous. For, in order not to lose too much of the available sectional area of the body, the lamination in such armatures is usually made rather coarse, but it is just the fineness of the lamination, and not the thickness of its insulation, that avoids in a higher degree the generation of eddy currents. The oxide coating created by heating the iron is a very

* Ernst Schulz, "Elek. Zeit.," Dec. 29, 1893. See The Electrical World's Digest, "Iron in Armatures," volume XXIII., page 91, Jan. 20, 1894, and page 248, Feb. 24, 1894.

effective and suitable insulation of the armature core laminae.

In the following table, values of the ratio k_1, of the net to the total core section are given for various thicknesses of the iron, and for the different modes of insulation now in use:

TABLE XVIII.—RATIO OF NET IRON SECTION TO TOTAL CROSS-SECTION OF ARMATURE CORE.

Material.	Thickness, in inches.	Insulation.	Value of k_1.
Sheet iron (discs or ribbon) ..	.080	Paper or asbestos	0.95 to 0.90
" " ...	.040	" " "	.92 " .88
" " ..	.020	Paper or enamel	.90 " .85
" " ...	.010	" " "	.85 " .80
" " ...	.010	Oxide coating	.95 " .90
Square wire	.080	Cotton covering	.90 " .80
" "	.040	" "	.85 " .75
" "	.020	Enamel or varnish	.80 " .70
" "	.020	Oxide coating	.90 " .85
Round wire	.080	Cotton covering	.80 " .70
" "	.040	" "	.75 " .65
" "	.020	Enamel or varnish	.70 " .60
" "	.020	Oxide coating	.85 " .80

In large ring armatures, for the sake of ventilation, air spaces are provided in modern machines by means of light brass frames inserted in certain intervals between the core discs. In calculating the radial depth, b_a, of the body, the sum of these distance-pieces is to be deducted from the total length, l_a, of the core, the reduced length so found being used instead of l_a in formula (18).

(To be continued.)

The Practical Importance of Resonance in the Transmission of Electrical Power.—V.

BY F. W. DUNBAR.

Figs. 7 and 8 are graphical representations of the resonance of a line 800 miles in wire length, of .2 ohm resistance per mile and of a mutual capacity of .010 microfarads per mile—the approximate value which would result from a wire separation of 12 inches on an ordinary pole line. The frequency is 80 ~ per second.

Fig. 7 shows the current, power factor, and energy de-

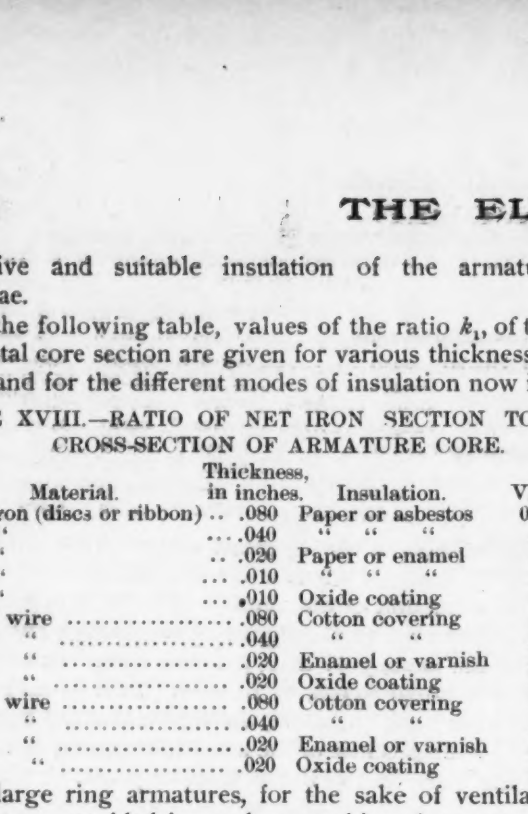

Current in Milliamperes for 2 volts max.
Steady E.M.F. of 2 volts
A
Current at the Origin
B
Power-factor at the Origin
(Cos. θ)
Power in Milliwatts for 4 volts
C
Energy delivered to the line
Abscissae are values of Lω
l/2=400 miles. R. =.2 ohm per mile. C/2=0.010 mfds. per mile.
Elec. World

FIG. 7.

livered at the transmitting end of the line, and Fig. 8 shows the current, power factor and energy per unit (or, in this case, per 4 units) drop in voltage which result at the distant end of the line.

It will be noticed that at the origin the power factor varies through unity and is equal to unity both when the current is a maximum and when it is a minimum—the latter case, of course, simply indicating that the reflected wave is in direct opposition to the direct, and consequently the only energy transmitted is the small amount due to the imperfect elasticity or imperfect *resiliency* of the line. As the value of $L\omega$ increases it will be noticed that the power factor at the

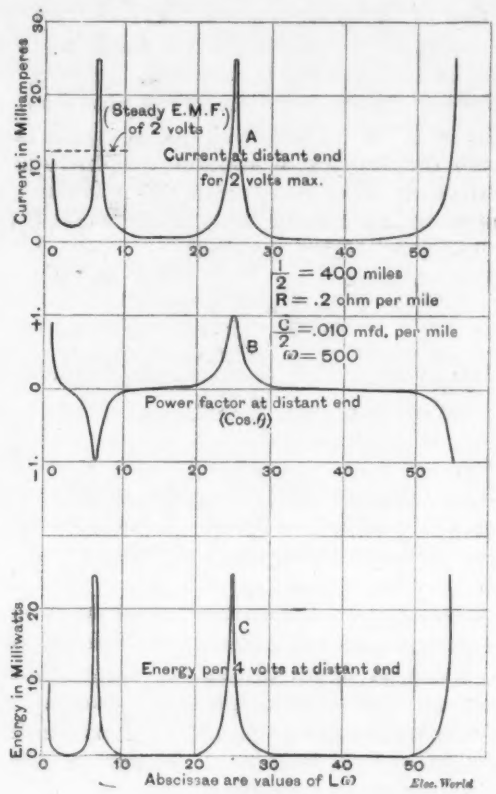

Current in Milliamperes
(Steady E.M.F. of 2 volts
A
Current at distant end for 2 volts max.
l/2 = 400 miles
R = .2 ohm per mile
C/2 =.010 mfd. per mile
ω= 500
B
Power factor at distant end (Cos. f)
Energy in Milliwatts
C
Energy per 4 volts at distant end
Abscissae are values of Lω
Elec. World

FIG. 8.

origin more nearly reaches the values of + and — zero at points corresponding to the maximum difference in phase between the current and E. M. F., and that it becomes more and more difficult to force the circuit to respond in any degree to any vibration other than that rate to which it is tuned.

At *C*, Fig. 7, the energy which can be forced out upon such a circuit is shown. This curve is found by taking the product of *A* and *B*, and consequently gives the energy in milliwatts for every four volts (maximum) of E. M. F. applied.

It will be noticed that at a value of $L\omega = 1$, corresponding to a value of $L = .002$, which is approximately the value which would naturally occur if the present methods of line construction were employed, it is practically impossible to force any energy out upon the line at this rate of alternation. But if the inductance be increased from .002 to .012 henrys per mile, then the line becomes perfectly resonant and will transmit a thousand or more times the amount of energy than it would be able to were the line constructed with no reference to the capacity and inductance. This example was chosen to illustrate the fact that long lines of low copper resistance are naturally resilient and that it will become *necessary* to introduce additional inductance into circuits which are to conduct a large current or power to great distances.

Curve *C*, Fig. 7, farther shows that as the resiliency of the line increases, the amount of energy which can be forced upon the line by any period other than that period for which it is in resonance becomes so small that it is represented by zero on the scale of the plot.

Fig. 8 represents the conditions at the distant end of the circuit.

It will be noticed that at this end the power factor varies

through zero and reaches a maximum at each maximum value of the current. The negative maximum (— 1) indicates, as we have previously seen (Figs. 1 and 2), that there are an odd number of wave lengths in the circuit, while the positive maximum (+ 1) indicates that there are an even number.

The energy curve at the distant end is exactly similar and practically equal in value to the energy curve at the origin, indicating, as we have already shown (Fig. 4), that when the circuit is in resonance the line loss due to the "electrostatic absorption" is practically zero.

It is obvious that if a higher rate of alternation had been assumed in place of this comparatively low rate, 80 ~ per second, then *natural* resonance could have occurred on this comparatively long circuit, and also that by even a slight increase in the inductance complete resonance would be possible on much shorter circuits.

Thus if the rate were increased to 800 ~ per second, the inductance to .1 henry and the capacity kept constant at its natural value, then complete resonance would be possible at a distance of less than 10 miles.

Fig. 9 is designed to show that even where comparatively

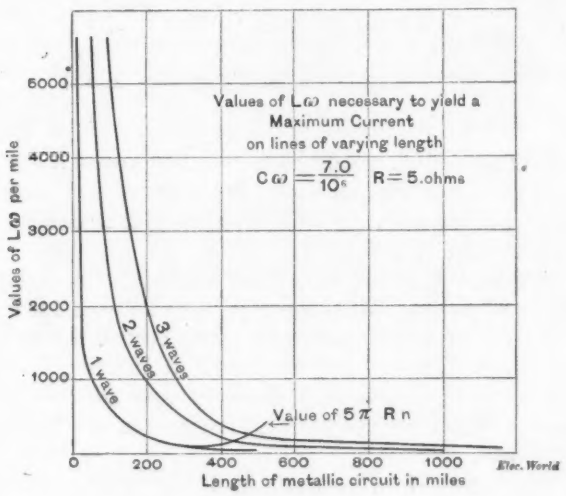


FIG. 9.

small wire is to be used (No. 12 N. B. S. G.), and without attempting to alter the natural value of the capacity which would occur upon a pole line containing such a circuit and with even as low a rate as 80 ~ per second, it is still possible to "tune" perfectly such a circuit by increasing the inductance. Thus, referring to the plot, it is possible to perfectly tune all length lines less than 330 miles to one wave length before a value of $L\omega$ is reached, which no longer exceeds $5\pi Rn$. It then becomes possible to tune perfectly by using two wave lengths up to 425 miles, and by using three wave lengths up to 470 miles, and so on. Of course an increase in the rate of alternation facilitates the tuning of the circuit by allowing a lower permissible value of the inductance, L.

Fig. 10 illustrates an example of resonance on short lines. The resistance per mile is 2 ohms, the capacity is .5 microfarad (.25 microfarad mutual) per mile, a value corresponding to a cable of rubber insulation, and the inductance is .020 henry per mile, a value readily obtainable in several ways. It will be noticed that the current rapidly decreases as the circuit increases in length and at a length of 15 miles or a distance of 7 1-2 miles is a minimum. At this point the power factor (not shown) is also a minimum, and the circuit is practically incapable of transmitting power at this rate of alternation, i. e., 320 ~ per second. But on increasing the circuit to a length of 30 miles, or a distance of 15 miles, the resonance is perfect and the circuit will transmit several hundred times as much power as it was capable of transmitting a distance of 7 1-2 miles, and the true resistance of the circuit is but one-half the resistance which it would offer to a steady E. M. F. A second and third

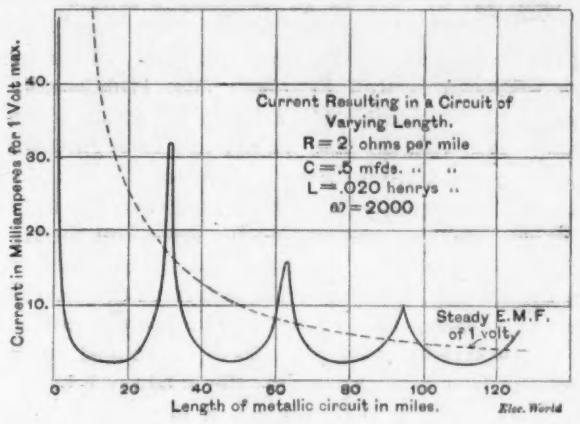


FIG. 10.

maxima occur at two and three times this distance and yield approximately one-half and one-third as great a current.

But while the value of $L\omega$ (40) is capable of yielding perfect resonance for the first maximum corresponding to one wave length, yet the second and succeeding maxima are not perfectly resonant, and as the number of wave lengths increase the departure from true resonance increases, for $L\omega$ only exceeds $5\pi Rn$ at the first maximum in this case.

The effect of this decreasing ratio between $L\omega$ and $5\pi Rn$ is clearly shown in the plot by the gradual flattening of the curve as the distance increases, the decreasing ratio between the maximum and minimum values and the failure to reach a maximum of twice the value secured by a direct current. Thus, at 126 miles the maximum is but 160 per cent. instead of 200 per cent. of the value of the steady current, and the power factor would show a much greater decrease.

Up to this point the circuit has been assumed to contain no receiving instruments at the distant end. It can, however, be readily shown that while the introduction of the receiving instruments at the distant end necessarily alters the value of the current and consequently modifies the problem, yet resonance can still be secured and obeys the same laws which I have pointed out, modified by the impedance of the receiving instruments. Thus, when the receiving instruments are themselves "tuned" by the now well-known laws governing localized capacity and inductance, to the same pitch to which the line has been tuned, then not only will the copper resistance of the line be decreased one-half, but the receiving instruments will receive their energy with no difference in phase between the current and E. M. F. and a truly resonant circuit will result.

The object, however, of these articles was to show that the line loss upon a circuit conveying an alternating current, instead of being a loss necessarily large, and increasing rapidly with the distance, can be made 50 per cent. smaller than the loss due to a direct current of the same voltage by adjusting the inductance and capacity of the circuit so that the natural period of vibration of the circuit will coincide with the rate of alternation which is desired to be transmitted.

Frozen Soap Bubbles.

Prof. Dewar, in one of his recent lectures, in which he performed quite a number of interesting experiments, showed that very fragile bodies, such as a soap bubble, may be frozen solid.

On the Design of Electromagnets for Specific Duty.*

BY P. MATTHEWS.

After carefully reading Mr. Cary T. Hutchinson's reply to my criticism of Mr. E. R. Carichoff's article "On the Design of Electromagnets for Specific Duty," and again referring to the original article, I am still firmly of the opinion that my criticism is well founded. Mr. Hutchinson does not interpret Mr. Carichoff's article; he states something different. He tells us that we are not to regard the line *O F*, Fig. 1, of Mr. Carichoff's article, called the air gap characteristic, as representing the relation between the induction in the air gap and the magnetomotive force, but the relation between the induction in the iron and the magnetomotive force in the air gap, divided by the length of the iron circuit. This word "characteristic" must have a peculiar meaning if an iron characteristic is simply a $\mathfrak{B}$ $\mathfrak{H}$ curve and an air gap characteristic is a line expressing the relation I have mentioned. The words used by the editor in passing judgment on my article show that he has taken the plain, straightforward meaning of the air gap characteristic which I did, for he says that when $\frac{d\mathfrak{F}}{d\mathfrak{B}}$ are the same for both iron and air gap, we have the conditions intended by Mr. Carichoff to represent the conditions for maximum work. The further statement of the editor puzzles me. Does he really think that in order to increase the area of the pole piece of an electromagnet I supposed that it was necessary to increase the section of the core? Returning to Mr. Hutchinson's article, the theorem which he establishes by simple mathematics is decidedly interesting, but I cannot agree with his statement at the end that "the results are similar to the conditions for maximum work of a battery, and, like them, are independent of the magnetomotive force." Does not the direction of the tangent to the iron $\mathfrak{B}$ $\mathfrak{H}$ curve depend as essentially upon the magnetomotive force for a given length of iron as upon anything else? Obviously, it does, and this is where all the difficulty lies. Consider the sketch, Fig. 1. Suppose the conditions for maximum work are satisfied for a given current circulating round the core, the polar area being the only variable. If we increase the current the induc-

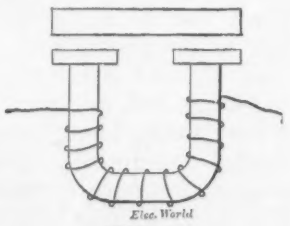


FIG. 1.

tion in the iron will increase, and the tangent to the iron $\mathfrak{B}$ $\mathfrak{H}$ curve will alter in direction, hence the conditions will no longer be satisfied, since the line *O F* will not alter in direction. We have, therefore, to change the polar area and see if the conditions are again satisfied, but we might as well calculate the force for a different polar area at once, see if the change makes the force increase or diminish, and arrive at its condition for maximum in that way.

When we consider that the method, in addition to the difficulties I have pointed out, does not take into account the magnetic leakage, we are driven to the conclusion that, as it stands, the method is of very little practical use, as I inferred in my previous article.

We must remember that the leakage factor is so important in an electromagnet that if we neglected it we should get a polar area, by this method, so far from the best polar area that the method would be worse than useless. The leakage, however, may be taken into account if we regard it as independent of the polar area—a condition which it will not in general accurately fulfill, but may approximately in some cases.

Let R = the equivalent reluctance of the paths of the leakage lines shunting the air gap. Then, if we work out the condition for maximum force we get

$$\frac{d\mathfrak{B}}{d\mathfrak{F}} = \frac{R\,A - L}{R\,L},$$

where $\mathfrak{B}$ = lines through core,
$\mathfrak{F}$ = magnetomotive force expended on iron,
A = area of air gap,
L = length of air gap.

Determining $\frac{d\mathfrak{B}}{d\mathfrak{F}}$ from the direction of the tangent, at different points on the iron curve expressing the relation

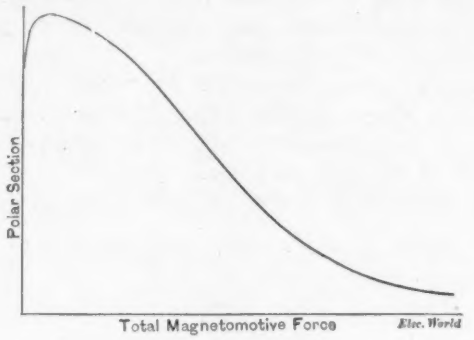


FIG. 2.

between M and N we could calculate the areas A for these points by the above equation. We could then construct the accompanying curve, Fig. 2, which might in some special cases be of value.

The ordinates give the best polar section for a given core and length of air gap, when the core is to be used for several magnets and outside conditions demand certain definite total magnetomotive forces. As, however, the limiting condition for ampere turns is generally the watt loss and consequent heating, for different magnetomotive forces we would use different cores.

The best method of procedure, I am convinced, is by direct experiment.

BY E. R. CARICHOFF.

Mr. Matthews' second attack on the statements put forward in my article "On the Design of Electromagnets for Specific Duty" warrants, I think, a few further remarks. He questions the right to call the line *O F* in Fig. 1 of my first article the air gap characteristic. The iron characteristic is there given as a $\mathfrak{B}$ $\mathfrak{H}$ curve, which everybody knows means the abscissas of the total characteristic per unit area, divided by the total length of magnetic circuit, and, consequently, I did not think it necessary to state that the line *O F* represented the total air gap characteristic per unit area, divided by total length of magnetic circuit, as it seemed to me obvious that this was to be inferred from the $\mathfrak{B}$ $\mathfrak{H}$ curve being given instead of the $\mathfrak{B}$ $\mathfrak{F}$ curve for the iron and both curves being plotted on the same scale. By taking values per unit length of magnetic circuit, we get the total values for any length of magnetic by simple multiplication.

The statement that "when the function $\frac{d\mathfrak{F}}{d\mathfrak{B}}$ is the same for both iron and air gaps, etc.," is taken from a paragraph near the end of my first article.

In ancient days we were taught that when the external resistance equals the internal resistance of a battery the current in the circuit is a maximum. When μ is constant the maximum work, as previously defined, is when air gap reluctance equals iron reluctance. When μ is variable the first differential coefficients are equal.

In answer to the first "conclusion to which" Mr. Mat-

* See The Electrical World, Jan. 27, Feb. 17 and 24, 1894.

thews so frankly avows he "is driven," namely, that the method is of little practical use, I maintain on the contrary as a result of actual experience, that one can in the least time, with the least chance of error, design a magnet for a specified purpose, with the expenditure of the least material, or the least electrical energy as required, or with just the proper proportion of the two.

Mr. Matthews' long essay on leakage does not apply to the case in point, because, if he will refer to the second section of my article, he will see a form of magnet in which leakage is almost negligible. His final conviction that the best method of procedure is by direct experiment is also inapplicable, as my first paragraph stated that the method was evolved to suit the exigencies of a case where there was no opportunity for experiment, and none permitted.

In conclusion, I may state that on actual trial, magnets so designed do exactly what they are calculated to do, and thus the cost and time of any "direct experiment" are saved, as well as the time spent in trial calculations; and that, therefore, the method is of great practical use.

Electrical Shop Equipment.

BY HOWARD L. INGERSOLL.

Shops, factories and mills at the present time are, for the most part, well equipped with modern appliances in steam driven machinery. In a few printing and lithographing establishments, where the necessity of cleanliness is combatted by the tendency of belting to fling dust about the room, line shafting has been replaced by a motor in each room. This reduces belting and shafting by a half, and the improvement is quite marked.

The complicated fixtures—shafts, countershafts, pulleys, hangers and belts—entailed by the common means of transmitting power, present at the same time favorable, and seriously objectionable features. In their favor, it may be said that they are well known; improved by all good appliances obtainable; and, in cases where very small work is done, are the best known ways of transmission.

Offsetting this, we have the first cost of material and placing, which is considerable; they always require a great amount of attention and repair, occupy much valuable space, furnish easy and multiple chances for accident and loss of life, and, furthermore, tend to stir the latent particles of dust and dirt, cause them to become an ingredient in the air breathed by workmen and a deposit on all articles within reach. These are objections—serious ones, too—which, in cases of shops supplied with medium and heavy machinery, outweigh the favorable qualities which have made our present equipment the rule.

Considering, first, the betterment of a shop already constructed and running, let us see how changes may be applied. This establishment has its own power plant—boilers, engine, etc. Let the same power plant remain to serve in the new order. With the addition of a generating plant of one or more dynamos, there will be the basis for an electrically driven manufactory. From the generating plant the current is taken to the separate departments by ordinary means. It is distributed through the department by means of a conductor, which may be placed in a similar position relative to the machinery that the line shaft occupied. The hinging point of the change comes here. Each large and independent machine contains a motor in some out of the way part of its frame, which, through gearing, furnishes the driving power.

As to the application of the motor to the various tools, these plans are the result of dynamometer tests with different ones, relative to determining the power required for each under the different conditions appearing in every-day practice. The designs are the outcome of attempting to locate the motor in a protected, yet convenient spot, in the frame of the machine. A complete illustration of this is not necessary, and we will only specify in one or two cases.

First, let us take a lathe. The one experimented with was a 16-inch lathe, and various tests were made with different materials and cut up to the maximum. It was found that under full load (with belt just holding) the power necessary averaged 0.2489 h. p. This includes friction of adjunctory parts used on lathes. Therefore, with a 1-h. p. motor, wound with resistance in series with field, and the range of speed adjusted at 800—1,600 revolutions per minute, the requisite change of speed and a considerable excess of power would be realized. The operator has a switch in circuit with the above mentioned resistance, which enables the regulation (now made by cones) and the reversing to be done. Thus, the overhanging shipper is done away with.

The motor, *M* (Fig. 1), is located under the headstock, which hinges on lugs *H*, at the back of the bed, which allows of lifting the headstock to examine the motor. It is the only means of access to the motor, as the cabinet at the head end is a closed casting. The motor rests on a shelf cast on the cabinet, and ribbed for rigidity. The headstock drops on V-ways and the wrist bolts, *W*, at the front clamp it solidly in place.

The motor shaft and armature are represented by *b* in

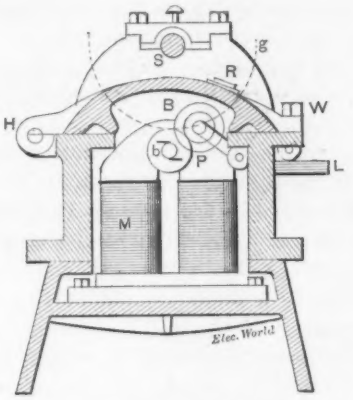


FIG. 1.—LATHE MOTOR.

Fig. 1, and the pinion *P* is of such a ratio to *g* (gear between bearings on spindle) as will give proper velocity ratio for highest speed. *R* is the operator's regulating switch on top of headstock. *B* is the back gear, operated by a stop lever at *L*. The back gear is thrown in by offsetting *g* This gear *g* has an extended hub on one side, through which is a stop or pin fitting into a hole in the lathe spindle. To set *g* for back gear, it is moved from the face plate into the position above the pinion on the back gear arm, then the gear *d* on *B*, which is above *P* and gears with it, and the pinion *a* on *B* are thrown into gear by *L* (see Fig. 2).

This makes a compact arrangement, the motor being en-

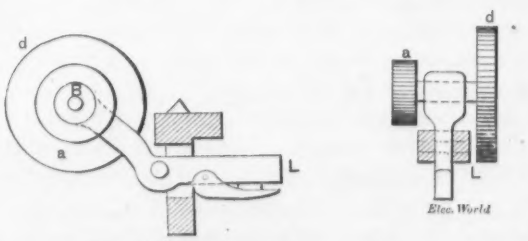


FIG. 2.—DETAILS OF ELECTRICALLY DRIVEN LATHE.

tirely hidden and at the same time readily accessible. The screw cut, feed and other details are applied in a similar manner to ordinary lathes.

The planer offers a ready location for the motor underneath the bed, on a cast shelf, enclosed, and free from dirt.

The difficulty to be overcome is the reverse and quick return. The solution to this is quite simple. It necessitates a friction clutch between two gears on the planer spindle. These gears, Fig. 3, are of different size (g and G. P is the pinion on the motor, Fig. 3, and is so arranged as to drive

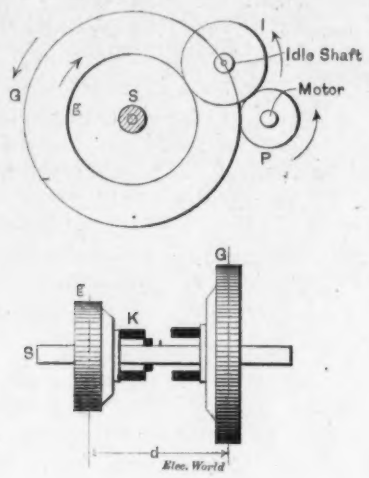


FIG. 3.

an idler I, gearing with the quick return gear g on the spindle of the planer. Another pinion at a distance $= d$ from P drives the feed or forward gear, G direct. Thus we obtain a slow cut, and by having g the requisite ratio to P, we can have any quick turn desirable. The clutch K is operated by a shifter on the planer table, such as is ordinarily used for shifting belts. The motor is always rotating in the same direction, and, furthermore, the friction clutch between g and G throws the load on gradually. If desired, a switchboard can be used to give changes of speed. The coupling to a shaper may be made in a similar manner, with the exception that the clutch is unnecessary, the Whitworth quick return being entirely sufficient. The motor would be placed in the bottom of the casting and geared to the quick return of the common shaper.

For a drill press, the connections would be similar to a lathe, the motor either boxed at the base, and the stepped cones and belt used to connect power with spindle, or placed on a shelf beside the spindle and geared to it.

For driving power for small machines—grinding machines and the like, a few of which are necessary in any shop—belting would probably be indispensable. The cost of these machines, supplied with an independent motor, would be so much compared with their earning capacity that it would be useless to put independent driving mechanism in each. Therefore, it would seem that the surplus power of some large machine might serve the few small tools. The lathe, or other large tool, would be connected to the others by belting, placed along walls of the room so as to be out of the way. The motor in this lathe could be run, whether it were used to propel the gear on the lathe or not. Thus it would furnish an ever ready power for the small sub-tools. The small amount of belting and necessary adjuncts to consummate this would not be a factor.

The arguments for and against present methods in equipment have been given above, together with the advantages to be derived by a change. The only valid argument against this projected method is the cost of these specially built machines. However, when once the manufacture is undertaken, and the machinery given a fair trial, its advantage will be proven clearly. It may be said here that the writer knows of two large firms, builders of machine tools and their accessories, who are experimenting along these same lines. One of them has a line of tools on the market.

To return to the question of economy. The extra cost of the motor would be small compared with the cost of additional labor required to attend shafting and repair belts. Further, the work of one man will be more productive when the system is tried. Besides this, nothing has been said of the cost of keeping a shop in a cleanly condition, which would be much decreased by avoiding belting. In the case of an old shop, while the utility would be unquestionable, yet the advantage of a change might be uncertain, owing to the expense. But where a new equipment and new establishment are planned, economy and all other considerations point to the fact that the first additional outlay would be well placed.

The noisy and dirty workroom will be changed to a place of quiet and orderliness, and be a matter of pride to the proprietor who has had the wisdom and foresight to keep pace with the tireless march of progress, and the workers in these places will have better nerves, senses and lungs.

Baseball by Electricity.

When the New York Baseball Club started out to win the series of games they have been playing at the Polo Grounds, New York City, it is not probable that they were aware their actions were being actively watched by a large audience several miles removed from the scene of action. Such, however, was the fact, and a double set of cheers was sent up for every good play that was made. The second audience was located in the Standard Theatre, but by an ingenious contrivance it was enabled to view the slightest move of the players, and the anxiety of those present was just as great as though they had been occupying the real grand stand.

A large flat or curtain was painted to resemble a baseball field. At the back was a grand stand and a "diamond" was laid out in regulation order. Every base, however, was represented by a square hole. Under every painted player was a round hole backed by a color which corresponded to the team in the field. Small bells were arranged on various parts of the curtain and near them a sign indicated what various signals would mean. There were also holes to represent the "strikes" and "balls" and to chronicle the fact of a player getting out. Back of every hole was a miniature panorama arrangement on which the various signals were indicated.

The news from the Polo Grounds was received by a telegraph operator, who sat in the place usually occupied by the orchestra leader. As the news came in it was recorded and was reproduced in fac-simile on the curtain, which was accomplished by a series of keys, setting in motion small motors behind each opening. "One ball" was indicated at the opening marked "Ball" by the appearance of a figure 1. "One strike" was recorded in a similar manner. When a player made a base hit he would be seen to disappear from the "home plate" and reappear in the opening at first base. Sometimes when a ball was being pitched a player would disappear from the base opening, and if he reappeared at the next base the audience knew he had stolen a base. More often, however, his disappearance would be followed by the appearance of 1 in the "out" hole, and then the audience knew he had been caught in the act.

The batting order was represented by two signs, with the players and the numbers marked on it, the number corresponding to the batsman appearing on the home plate. All fouls were noticed by a bell, while the double ringing of another bell recorded a "bunt." On the other side of the diamond a bell ringing once, twice, or thrice told of one, two or three base hits, or four times for a home run. When a fly was struck, a large pictured "animal" of the same name appeared just to the left of the pitcher's box.

The whole arrangement was quite unique and brought down the house with its instant record of a game played so far away. It was quite amusing to watch the excitement of the audience when a hit was made. The contrivance is the invention of M. D. Compton, who intends to introduce it in the larger cities throughout the country.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM PRINCIPAL FOREIGN ELECTRICAL JOURNALS BY CARL HERING

ELEC WORLD, N.Y.

ELECTRO-PHYSICS.

Dielectrics.—A Physical Society paper by Mr. Appleyard is abstracted briefly in the London journals of May 18; on testing the insulation resistance of celluloid placed between metal sheets he noticed that the resistance, which was very high, decreased as the time of the application of the battery was increased; it diminished greatly with the increase of battery power and a considerable amount of hysteresis was observed; using mercury in place of the metal sheets the abnormal results disappeared. Some experiments with mixtures of gutta-percha and coarse brass filings, for use as high resistances, are described.

In "La Lum. Elec.," May 12, Mr. Lefevre discusses mathematically at some length certain theoretical considerations and the application of the theory of Lord Kelvin, and gives some experimental verifications.

Condenser Discharges.—In an Academy paper by Mr. Swyngedauw, abstracted in "L'Ind. Elec.," May 10, he discusses the proportion of the discharge of a condenser between two conductors in shunt circuits, one of which contains an air gap; among other things he shows that the quantity of electricity passing through one of the shunt coils may be more than ten times as great as the total charge.

Electromagnetic Induction.—A Physical Society paper by Mr. Bryan on "Electromagnetic Induction in Plain, Cylindrical and Spherical Current Sheets and its Representation by Moving Fields of Images" is abstracted in the London journals of May 18.

Oscillations.—A Physical Society paper by Prof. Minchin on the "Behavior of Certain Bodies in Presence of Electromagnetic Oscillations" is abstracted briefly in the London journals of May 18.

MAGNETISM.

Magnetic Properties of Iron at High Temperatures.—Mr. Curies' Physical Society paper is abstracted in "L'Elec.," May 12; he states, among other things, that the intensity of magnetization is constant as the temperature increases, then decreases at an increasing rate, the maximum rate being at about 745 degrees C.; from 950 to 1,280 degrees the intensity of magnetization diminishes only very slowly, while at the latter temperature it increases suddenly to half of its value and from there to 1,365 degrees it again diminishes.

Manganese Steel.—The Lond. "Elec.," May 18, abstracts briefly some experiments with the magnetic qualities, in a paper by Mr. Hadfield, read before the Iron and Steel Institute.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Standard of Light.—"L'Ind. Elec.," May 10, contains a paper by Mr. Guillaume, in which he describes the Lummel and Kurlbaum method for determining a fixed temperature for the platinum standard; the method was briefly described in the Digest last week; the temperature is defined by the condition that the total radiation after passing through a layer of water two centimetres thick between two plates of quartz, 1 millimetre thick, is reduced to one-tenth of its intensity. He gives in a diagram the curves showing the relation of the lengths of the waves and the corresponding energies, for sun light, arc light and gas; also for the arc light after traversing five centimetres of water; the ratio of the energy in the visible spectrum to the total energy increases, as does also the ratio of the energy absorbed by the water to the total energy of radiation; the sensitiveness of the proposed method depends on the way in which this ratio varies with the temperature; he shows that under the most favorable conditions the pressure does not permit the temperature to be defined with a sufficient precision for a standard; he discusses the matter theoretically and shows that if the radiation measured by the bolometer increases one per cent., corresponding to an increase of temperature of a little over one degree C., the luminous intensity due to this increase will increase three per cent.; this is the weak point in the method, as a limit of error of one per cent. in the photometric standard requires a precision of one-quarter of one per cent. in the bolometric measurements. He describes in detail the way the method is carried out, showing that great precautions must be taken to insure sufficient accuracy; the impurities in the platinum modify the emissive power, but the nature of the surface is of less importance, as the evaporation of the metal keeps the surface the same; the calorific capacity of the bolometer varies with the thickness of the black layer; he describes an electrolytic method by which the platinum is blackened to a definite amount. He quotes from the authors, in which they say the reproduction of the unit is sufficiently easy if one has the proper apparatus; that the errors are less than one per cent. and that hereafter the photometric measurements at the Imperial Reichsanstalt, of Germany, where these experiments were made, will be based on this unit; they state that this new unit is well adapted to the photometry of lights of different tints, as it requires only a modification of the above defined ratio. In conclusion, Mr. Guillaume states that according to Mr. Abney all tints can be replaced in practice by white, to which has been added a certain proportion of a simple color; all illuminations can therefore be represented by an intensity factor and a formula for the color factor; this he considers a new idea which it would be well to develop.

International Ohm.—The Siemens & Halske Co., of Berlin, will hereafter use the international ohm as a standard of resistance in place of the legal ohm.

Kruppin.—According to a statement in "La Lum. Elec.," May 12, the new resistance material, Kruppin, the properties of which were given in the Digest Jan. 6 and Feb. 3, is an alloy of copper, nickel and manganese, the proportions of which, however, are not given.

Hummel Meter.—"L'Ind. Elec.," May 10, gives an illustrated description of the Hummel meter, which is used largely in Germany and which resembles in principle that of Prof. Elihu Thomson; a short description of the theory is included.

DYNAMOS AND MOTORS.

Theory of Alternating Current Motors.—In the "Elek. Zeit.," May 17, Mr. Cahen calls attention to an error in the mathematics of the article of Dr. Behn-Eschenberg (see Digest, April 28), and gives the correct mathematical deductions; the error does not appear to affect the practical results materially.

Alternate Current Induction Motors.—A paper by Mr. Potier, read before the Soc. Int. des Elec., is abstracted at some length in "La Lum. Elec.," May 12, and more briefly in "L'Ind. Elec.," May 10; it is of a mathematical character and has reference to the field.

Variable Speed Motors.—Mr. Leonard, in the Lond. "Elec. Rev.," May 18, replies to the recent inquiry of Mr. Seaman, whether the dynamo will not spark badly when working with its full current at one-tenth its normal voltage; Mr. Leonard replies that in no less than ten different generators with which his system is used, he has never met with the slightest tendency to sparking with any one of them, nor is any adjustment of the brushes required even when the field is reversed.

Domestic Motors.—In a well-illustrated article in "La Lum. Elec.," May 5, good illustrations are given of some small motors, most of them of American origin.

TRANSFORMERS.

Continuous-Alternating Current Transformer.—A translation of the paper abstracted in the Digest May 19, describing the Hutin & Leblanc transformer, is published with the illustrations in the Lond. "Elec. Eng.," May 4.

Closed Circuit Transformer.—A discussion of the general problem of the calculation of such transformers is given in a paper by Mr. Korda in "Comptes Rendus," volume CXVIII., No. 16.

ARC AND INCANDESCENT LIGHTS.

Life and Efficiency Test of Incandescent Lamps.—"L'Ind. Elec.," May 10, publishes in a large full-page table by Mr. Gasnier the results of a long series of measurements with a large number of different lamps, with the object of finding the variations of the luminous intensity and the consumption of energy at different periods of the life; the lamps were all of 110 volts and of 10 and 16 candles, and the test was continued, as a rule, up to 600 hours; the method of making the photometric measurements is briefly described. The results given in the table include the candle power, the consumption in watts and the watts per candle, as also the life of the few lamps which were consumed before the end of the test; the data in the table are of considerable interest, but do not admit of being abstracted.

Small Arc Lamps.—"L'Elec.," May 12, contains an illustrated description of the Buchet lamp, for currents of two to four amperes.

TRANSMISSION OF POWER.

High Tension Continuous Current Transmission.—In an article by Mr. Schultz in the "Elek. Zeit.," May 17, he discusses high tension continuous current transmission. Shunt dynamos, he claims, cannot be made for over 1,000 volts and series dynamos for not over 3,000 volts; for simple transmission with 6,000 volts, for instance, as distinguished from distribution together with transmission, he suggests using two series wound dynamos connected in series, each of 3,000 volts, to connect these over the line wires with two series wound motors similarly connected; it is essential that the motors be coupled mechanically, otherwise they will not be equally loaded and would require regulators. For transmission and distribution to two different motors, say at 4,000 volts, he proposed a similar arrangement, with the introduction of a third line wire connecting the junction of the dynamos with the junction of the motors; when both are running the middle wire conveys no current and when either one is used alone the percentage loss will be doubled and the speed will be slightly reduced, both of which would doubtless be of not much importance in practice.

Transmission of Power.—A descriptive article by Mr. Boucherot, containing a number of illustrations, is begun in "La Lum. Elec.," May 19, describing the installation at the Menier works; in the present part the installation and apparatus are described, as also some efficiency tests of a diphase Brown alternator of 75 h. p. and 40 periods, and a 15-kw. transformer.

ELECTRIC RAILWAYS.

Worm-Wheel Gearing.—The Lond. "Elec. Rev.," May 18, contains an article by Mr. Dawson, describing some tests with the Reckenzaun motor and gearing, made on an experimental track. There are two independent series motors of 10 h. p. to the truck, the weights and proportions being given; the worm is turned out of a solid piece of steel 6 inches in diameter and well polished, it has a triple thread of 6 inches pitch; the worm wheel is of phosphor bronze 15 1-4 inches in diameter and has 24 teeth; the whole is encased in a dust and waterproof casing containing oil; the inclination of the worm thread on the spindle is 45 degrees, this being the angle which gives the highest efficiency, the theory of which is given. Some practical tests made by the late Mr. Reckenzaun are given, showing a maximum efficiency of gearing as high as 95.4 per cent. when 1.64 h. p. was transmitted; the efficiency grows less for greater horse power and is highest for the least thrust on the tooth, which in this case was 132 pounds; these high efficiencies are said to have been due to careful design, to careful cutting and polishing of the teeth and to abundant lubrication; some efficient tests showing very good results are quoted from the experiments of Mr. William Sellers; a high peripheral speed, a limited pressure, an inclination of 45 degrees and a multiple thread are said to be necessary for the best efficiency, as also great care in workmanship and polishing. Some tests are reported in which the two driving wheels of a raised truck were belted together, one motor thus driving the other as a dynamo, showing an efficiency of the worm gearing of 84 to 88 per cent., allowing 7 per cent. for the loss in the belt and in the friction of the car axles; the worm wheel will drive the worm without any appreciable loss when the current is cut off, and it is stated that one man can push a loaded car on a level, running against the worm; the speed reducing power is 1 to 8, thus enabling cheaper and lighter motors to be used. The coupling of the various parts of the motors for different speeds is given and the results of some tests showing that between 3 and 8 h. p., which is the normal output, the efficiency is quite high; a table is given, but the curves referred to are omitted.

Electric Locomotive.—A brief description, with some data and illustrations, of a 1,200-h. p. locomotive to be completed for a French railroad, is given in the Lond. "Elec. Eng.," May 18, taken from the "Railroad Gazette," of New York: it is intended for trial in fast passenger service, and it is proposed to try the experiment first with storage batteries; the first locomotive is to have a power of only about 300 h. p.: the design is criticised, and it is questioned whether that output can be obtained: under the most favorable circumstances a weight of at least 1 cwt. per effective horse power is required for large electric motors: it is claimed that probably some mistake has been made in the design or data: the advisability of using accumulators is questioned, and it is claimed that the overhead trolley wire construction is the cheapest system, both as regards outlay and working expenses.

Heilmann Locomotive.—According to "La Lum. Elec.," May 19, this locomotive, which is now making regular trips, runs at a mean speed of 37.2 miles per hour; the maximum attained was 63; in returning the speed was 46 miles per hour.

Electricity for Heavy Railroad Service.—An article by Mr. Barnes, taken from the "Railroad Gazette," is abstracted briefly in the Lond. "Elec. Eng.," May 18.

Surface Contact Railway.—A brief description from "Genie Civil," of the Claret & Wuillieumier system, which is to be in operation at the Lyons Exhibition, is abstracted in "La Lum. Elec.," May 12; so-called automatic distributors every 30c feet send the current to the sections under the car, from which the current is then taken by the car. The same number contains a description by Mr. Richards of this system, in which a number of illustrations are given.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Cost of Electrical Energy.—An abstract of the discussion of Mr. Crompton's recent paper is given in the Lond. "Elec." and "Elec. Rev.," May 18, in both of which it is also discussed editorially; in the latter, the item of accumulators is referred to, among other things, it being thought that not enough attention was given to it in that paper; the same journal contains a communication. The discussion is limited almost entirely to the mechanical engineering features.

Train Lighting.—The Lond. "Elec.," May 18, states that the London, Brighton and South Coast Railway has decided that its electrically lighted trains are more serviceable than those lighted with either gas or oil; all three systems have been tried by this road, and the electrical system is estimated to render about 15 per cent. more service than the others; the first cost of gas for a train of 10 coaches, including buildings and producer plant, is stated to be $3,500, that of oil $600 and that of electricity $2,000; the yearly cost of maintenance with gas is $600 per train, with oil from $350 to $650, and with electric light only $250 per train.

Lightning in a Central Station.—In "La Lum. Elec.," May 12, Mr. Robert describes the recent destruction of a machine in a central station by a bolt of lightning, the machine being insulated; the lightning, after destroying the machine, passed to ground through the switchboard.

Berlin Station.—A translation of the article by Dr. Passavant, mentioned in the Digest May 19 and June 2, is abstracted briefly in the Lond. "Elec.," May 18; the systems of automatically announcing and localizing faults, mentioned in the former paper, were described in the Lond. "Elec.," May 18, 1893.

Theatre Plant.—"La Lum. Elec.," May 12, gives a brief description of the installation at the Olympia, in which electricity is used more than in any other theatre in Paris.

Electricity in Mines.—A few installations are described very briefly in the Lond. "Elec. Eng.," May 18.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Disturbances in Telephones due to Railway Circuits.—In an article by Messrs. Meyer & Muetzel, in the "Elek. Zeit.," May 17, they describe experiments to determine whether the disturbances are due to induction or to the earth currents; the experiments are described in detail and were made with telephones over the line of a railway. No noises were heard when both the outgoing and the return were overhead lines running along the railway, provided they were near to each other; if, however, they were as much as 2.5 metres apart the noises became as loud as usual; this shows that the disturbance was due to induction; they found that the earth currents, which caused quite a considerable disturbance in galvanometric researches, had very little effect in producing the disturbances in telephones; that they had some effect was shown by the fact that the noises were loudest when the telephone current went out over the line wire and returned through the earth, but the effect of the earth current was found to be due to the incomplete insulation of the line from the earth, notwithstanding that the insulation was so high that a galvanometer test could not locate any faults; they conclude that it is very important to insulate such telephone lines very carefully from the earth.

Train Signals.—"La Lum. Elec.," May 12, abstracts from the German an illustrated description of the Bormann system, in which telephonic communication is established between the locomotive of a moving train and the station, as also with other locomotives on the same track; a trial of this system has recently been made in Germany; contacts are made through three insulated rails placed between the two tracks and variously connected with the stations and with each other.

Pacific Cable.—A letter of Sir John Pender is reprinted in the Lond. "Elec. Rev." and "Elec. Eng.," May 18, and is discussed editorially in the latter.

Telegraphs in Persia.—A Society of Arts paper by Mr. Wells is abstracted briefly in the Lond. "Elec. Eng.," May 18.

Microphone.—The Anizan-Mercadier microphone is described and illustrated in "La Lum. Elec.," May 19.

ELECTRO-CHEMISTRY.

Purification of Sewage.—In "La Lum Elec.," May 19, Mr. Rigaut gives the results of the three official reports made on the Hermite process, one of which was unfavorable and the two others favorable, in order that they may be compared with each other; he speaks of another test which is being made, but not finished, by Dr. Chantemesse. In conclusion, he gives a detailed estimate for a city of 100,000 inhabitants near the ocean, on the basis of 0.3 gramme of chlorine per litre and 30 litres per inhabitant per day, the result being 2.19 francs (about 44 cents) per inhabitant per year; for an inland city, 98.6 cents per year per inhabitant, using salt in its solid form.

Tinning Cast Iron.—According to the Lond. "Elec.," May 18, a French company has adopted the process of first coating the iron electrically with nickel and iron or cobalt and iron; 1 kilogramme of sulphate, nitrate or chlorate of nickel is mixed with 3 kilogrammes of sulphate of iron and 1 kilogramme of citric or tartaric acid; or 1-2 kilogramme of the similar compounds of cobalt with 3 kilogrammes of sulphate of iron; this is dissolved in 100 litres of water and completely neutralized with caustic alkali; a current of 50 amperes per square metre is used.

MISCELLANEOUS.

Electrotropism.—The Lond. "Elec. Rev.," May 18, reports some tests of Messrs. Blasius & Sweizer concerning this phenomenon; a current of 108 volts was passed through water containing fishes, and they showed that when the head of a fish is directed toward the anode, calmness or even stupefaction ensued, but if the head is in the opposite direction, excitement is occasioned, accompanied by an effort on the part of the fish to escape the effect; it would appear, therefore, that the phenomenon of electrotropism would proceed from the effect of the current upon the nerves of sensation and there would ensue, according to Pflueger's well-known law of electrotonus, a decrease of excitability at the positive and an increase at the negative pole. If fishes are traversed transversely by the current they display a behavior analogous to dizziness, like in man when the current passes through his head, and they always sink on the side turned toward the anode. The results were the same with an accumulator current.

Relation of Mathematics to Engineering.—The paper of Prof. Hopkinson is concluded in the Lond. "Elec.," May

18, and is editorially discussed in the same issue, which contains also a communication from the author.

Electricity Users' Association.—The object and rules of this new association are given in the Lond. "Elec. Eng.," May 18, in which journal they are also discussed editorially; in general, the object of the association is to test apparatus and advise upon technical questions.

Electrical Advertising.

The accompanying illustration shows the electrically lighted advertising wagon of Keith's Union Square Theatre, New York. Its equipment consists of 32 chloride accumulators of type E, 9 plates, 200 ampere hours' capacity, furnished by the Electric Storage Battery Company, Drexel Building, Philadelphia. The cells are in four boxes, eight to the box, each box weighing, complete, about 400 pounds. Sixteen cells compose a set, one of which is in use on the wagon while the remaining set is being charged.

The wagon is wired with extra heavy rubber covered No. 12 wire and No. 14 specially made black silk cord runs from the wagon to the horses. The wagon carries 15 28-volt, 16-c. p. Dekhotinsky lamps in Edison sockets, and each of the four horses carries 2 30-volt, 16-c. p. lamps of the same make in Swan sockets, fastened between the ears and on the saddle. Bryant switches control the four circuits, two on the wagon and one each on the leaders and wheelers. The batteries are charged from the theatre plant in a small house built for the purpose in the rear of the main building.

This outfit has been in charge of Mr. R. Burbank, electrician of the theatre, and has been running very satisfactorily since it was brought out, in September, 1893. The wagon has been used in Boston, Providence, Philadelphia, Brooklyn and New York, and has made extended trips through the suburbs of these cities. As an advertising novelty it has been a great success and never fails to attract admiring attention.

ELECTRICAL ADVERTISING WAGON AND TEAM.

The Card Electric Railway Equipment.

Believing that on roads using 18-foot cars and under, over grades not exceeding 8 per cent., a single motor equipment may be made just as reliable as a double one, and will cost much less, both to install and maintain, the Card Electric Company, of Mansfield, O., has designed for such a service a motor which we illustrate herewith.

Fig. 1 shows the motor with the lower half of the case lowered, exposing the armature and field coils, for inspection or removal. A small chain block, fastened to a beam of the car body by means of an eye-bolt, and to the lower half of the motor case at the extension, shown in the centre, will enable one man to raise or lower it with ease. If the armature is to be removed, the journal caps are taken off, the case supported from below with a timber, a plank laid one end on the motor case and the other on a cross support in the pit; on this the armature is rolled out of its bearings away from under the car and on to the floor. An armature can be taken thus from such a motor easier and quicker, it is claimed, than any other motor on the market, and with less danger of injury.

A novel feature, shown in Fig. 2, is the steel bar for strengthening the cast extensions that form the spring supports. The bar rests in grooves, cast for the purpose, and is clamped down by two eye-bolts fastened by pins between the hinge ribs at the bottom, and clips over the top, dividing the strain equally between four points, overcoming all danger of breaking after long service through a gradual crystallization of the cast metal. There is no reason why such a frame of a motor should not last forever. It will be noticed that all the working parts are encased within the cast frame of the motor, and are absolutely protected from dirt or moisture at all times. Other features are the rigidity of the frame, and the impossibility of parts getting out of alignment. The gear case is made of malleable iron. In the top half is an opening with a hinged lid for inspecting the gears and inserting grease. The rear fastening to the bottom half is made in the form of a detachable hinge, for convenience in lowering and removal.

The core of the armature is built up of the best magnetic iron procurable, and is slotted to receive the conductors; these slots are insulated with mica, as are also the ends of the core. The shaft is of hammered steel, is four inches in diameter through the core portion, with a one inch square key to prevent turning; the ends are reduced to receive the commutator and oil disc, without impairing the strength or rigidity of the shaft, and terminate in bearings of generous size and length for the journals. The pinion is securely keyed on, and is further held by a nut.

The field coils are wound on forms, each one in two parts and separately covered, first with muslin saturated with

shellac, then with two windings of waterproof tape, and painted with two coats of insulating compound, after which they are bound together with tape and placed in an oven heated by steam to 150 degrees, and kept there until every particle of moisture is driven out. In winding the wire on the forms, each layer is coated with shellac until saturated. Made in this way, of wire having ample carrying capacity, and placed on the pole pieces so that no part of the coil is in contact with iron, and there kept dry and clean, they should last indefinitely.

The commutator is as simple, strong and durable as possible to be made, and by the use of first-class material and good construction, many, if not all, the bad features have been eliminated that have heretofore hung around that end of the armature shaft, and seemed to many to be inherent and an inseparable part of it. The parts of the commutator, other than the segments, are few, and are put together in an exceedingly simple manner. As sometimes happens, a segment, after a little wear, develops a soft spot, or for other cause becomes injured to an extent that demands its immediate removal. To do this is not a serious task with this commutator, requires little skill and may be done any number of times without injury to the commutator, and will, in many cases, prove a great advantage, not only in times of urgent necessity, but as a ready means of saving from rapid destruction an otherwise good commutator. In construction the segments are set up in a form and over them are driven with a heavy hammer rings of steel until further compression in that manner is impossible, but when the end plates are put on and screwed down, the degree of strain has been limited to a point when further compression will permit the rings being removed without the aid of a hammer. Another frequent source of trouble is from oil working its way along the shaft into the armature and destroying the insulation, and only a perfect metallic joint, which is seldom obtained, unless aided by other means, will

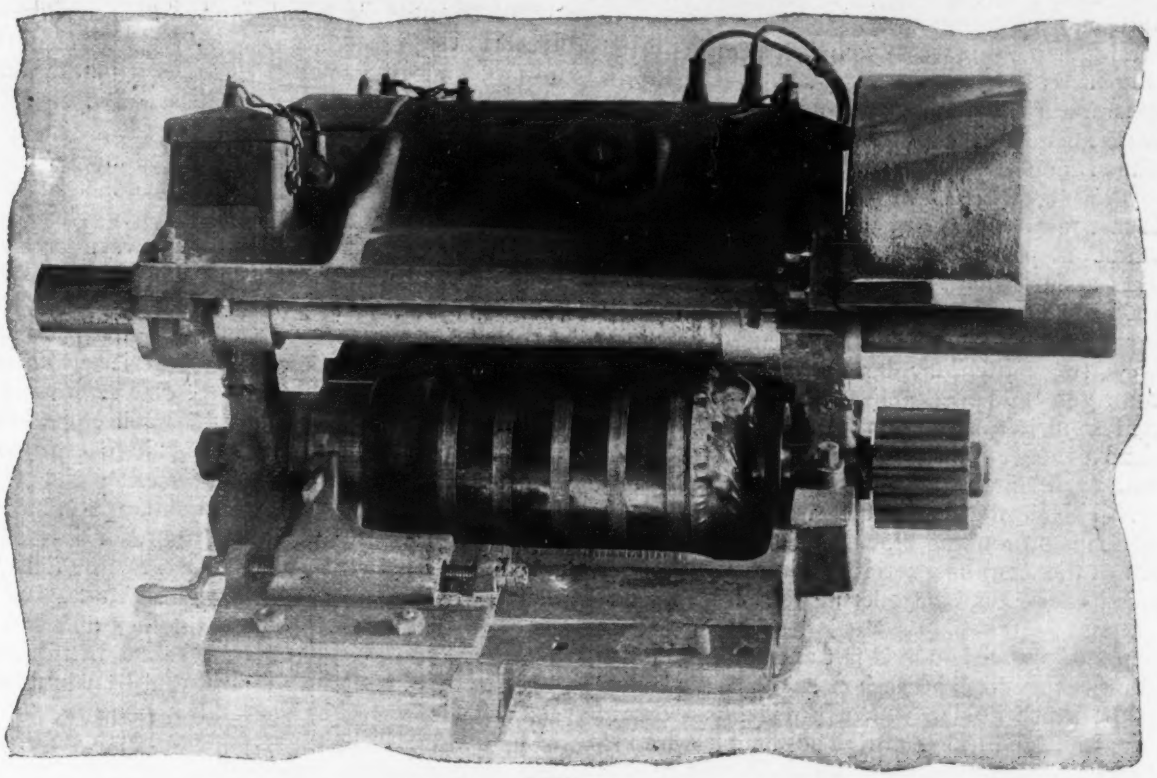


FIG. 1.—CARD ELECTRIC RAILWAY MOTOR.

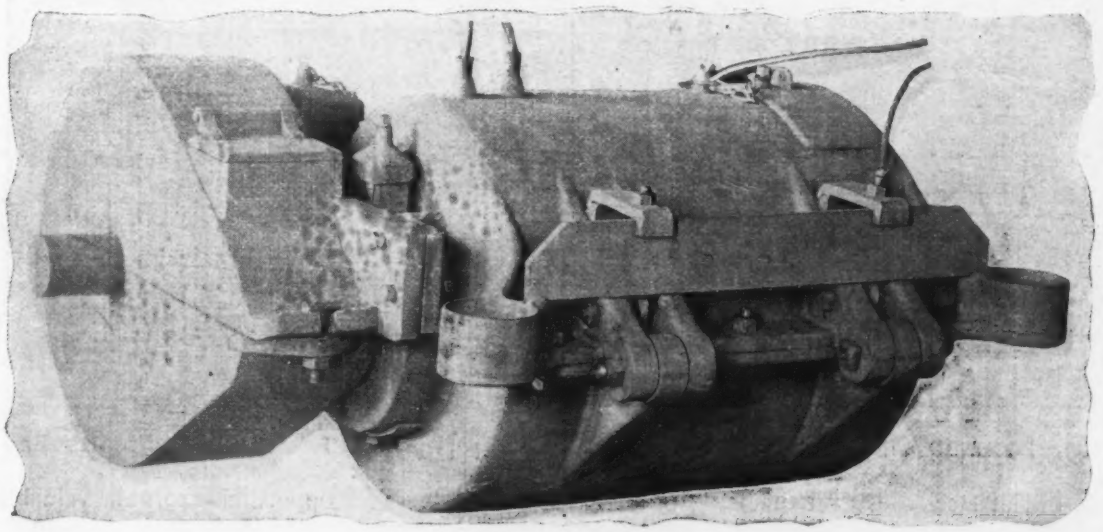


FIG. 2.—CARD ELECTRIC RAILWAY MOTOR.

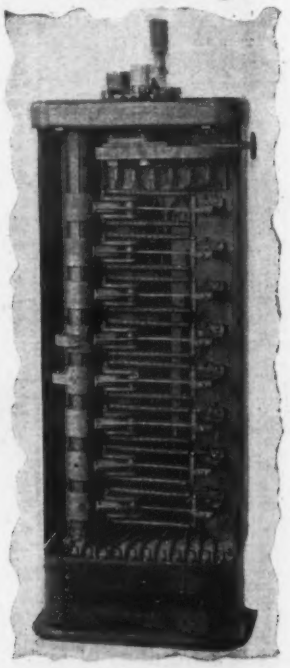


FIG. 3.—MOTOR CONTROLLER

prevent it. In this commutator, between the hubs of the end plates, is a rubber ring, which is of such size that when the commutator is on the shaft it will fit the shaft snugly and make a perfect union between all parts, and effectually prevent any oil passing through to the armature or working its way outward into the commutator.

The controlling stand, Fig. 3, is ironclad, being covered with iron at the back as well as the front, and is so well protected that moisture or dirt cannot possibly get inside. The design is neat, the height just right for convenience, and the movement of the handle easy and noiseless. The front cover is removed by raising a little and drawing it out. It cannot be put back wrong and cannot become displaced. The operating handle is placed centrally on the top of the cover and turns a short shaft, from which motion is transmitted to another shaft, shown at the left, by means of two small sprocket wheels and a chain. Immediately under the cover is the reversing switch, the handle extending through the case at the right. On the longer shaft are placed eight cams, insulated from it by heavy, hard rubber tubing and secured by hard rubber pins. Opposite each cam is a switch fastened by a suitable bracket or base to the back near the shaft. Each switch is provided with contact pieces to engage with clips on binding blocks fastened to the back. At the bottom of the stand is a series of binding blocks for making connection between controller motor, resistance and the line.

The brush holder proper is bolted fast and never intended to be moved or changed. The carbon socket has a radial movement in the brush holder, which provides for wear at the commutator and for turning off. The flexible wire terminals are fastened on the outside to the binding screws and are securely insulated from the frame, and protected from injury or moisture. There are no screw contacts on the motor except for connecting the two halves together.

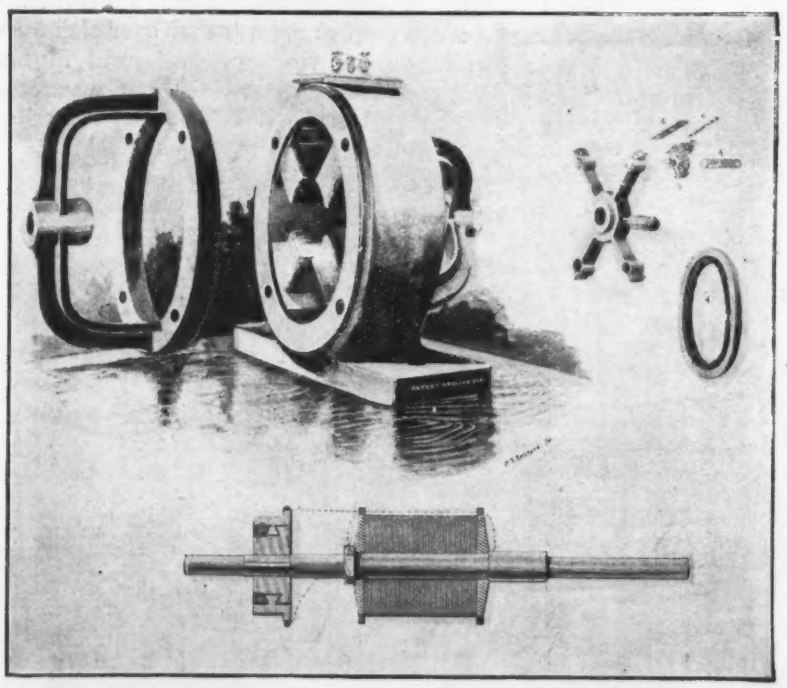


FIG. 1.—EXPERIMENTAL DYNAMO AND MOTOR.

The carbon springs are made of flat steel rolled on themselves a number of times to insure flexibility and give constant pressure on the carbons until worn out. A convenient arrangement for adjusting the tension is provided on the side of the holder. The carbons are replaced through the top opening in the case, and are not disturbed when the armature is lowered or removed.

All the parts of a complete car equipment have been carefully designed to accompany the system, including a controller rheostat, controlling switch and a simple yet efficient and easily applied attachment for turning off commutators in place on a mounted motor.

Experimental Electrical Apparatus.

The Institute for Home Study of Electricity of Cleveland, O., has designed and is now having manufactured two useful pieces of experimental electrical apparatus, consisting of a dynamo and motor and a combination measuring instrument.

The dynamo and motor, illustrated in Fig. 1, is fitted with self-oiling bearings, two sets of copper brushes and in design and operation is a practical machine. There are also furnished four insulated rings which, when connected to the commutator as directed, enable the machine to be used as an alternator.

By various changes in the connections, the machine may be made a shunt, compound or series dynamo or motor, either two or four pole; with separate excitation and the addition of the rings, which serve as collectors, it may also be made a single, two or three-phased alternator or motor. The armature and field coils winding may be made with larger or smaller wire than is sent with the machines, so as to employ higher or lower voltages and more or less current. The machine is very well adapted for a two or four-pole electroplater. In connection with the machine, instruction diagrams of field and armature windings and connections are given which make possible the above mentioned variations. The E. M. F. and current produced by windings of various sizes of wire are also given, and the machine will be sent unwound with full directions how to complete it, thus furnishing students and amateurs an opportunity to gain valuable experience.

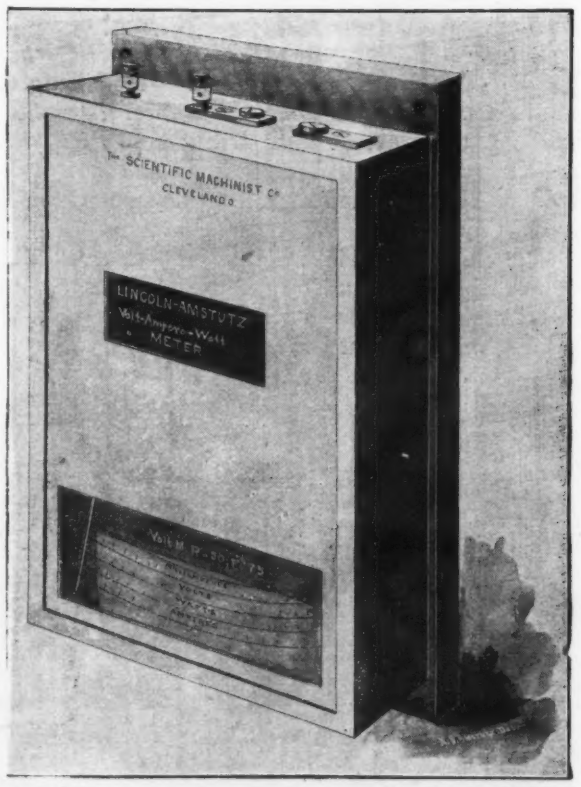


FIG. 2.—EXPERIMENTAL MEASURING INSTRUMENT.

In the combination measuring instrument shown in Fig. 2, a soft iron core is drawn into a magnetic field obliquely, the pull being opposed by gravity. The spool on which the coils are wound is made with an oblong opening, the height of which is four or five times its breadth, thus allowing the necessary freedom of motion to the core. By proper adjustments the direct reading scales can be made quite uniform from one end to the other. It will be seen that there

are no multiplying devices to get out of order, the only motion being the movement of the core and pointer on their support. The instrument is wound with two coils, one of fine wire and the other of coarse. There are four scales, two for amperes, one for voltage, and the fourth for watts.

Mammoth Generators.

The accompanying illustration shows the Walker Manufacturing Company's large direct coupled generator. The machine illustrated has a capacity of 2,000 h. p., has ten poles, and runs at a speed of 80 revolutions per minute. The company makes three sizes of generators on this plan, namely, 1,500 h. p., 2,000 h. p. and 3,000 h. p. capacity.

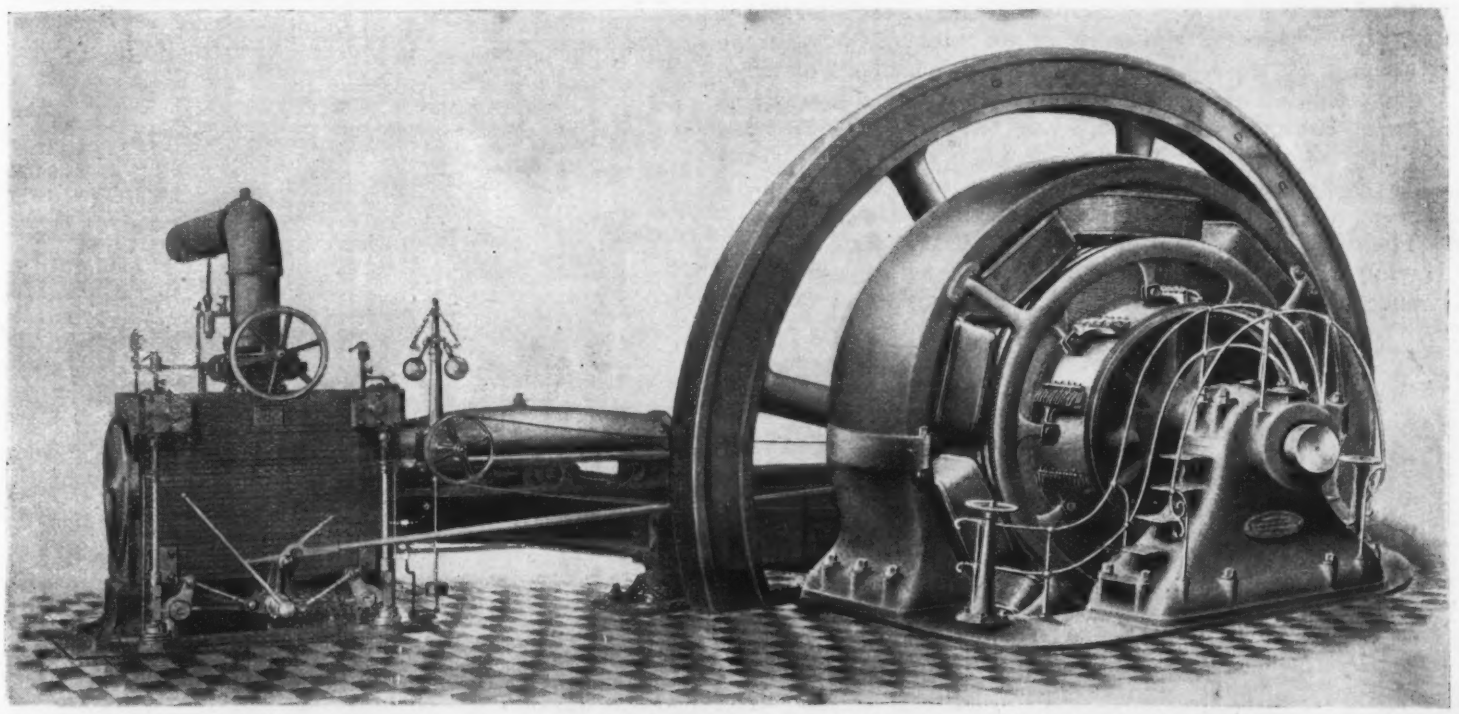
The bed plate of the machine is cast in one piece and rests on a solid stone or brick foundation, which is made a part of the foundation of the engine. From this foundation is built the enormous masses of iron which go to make up the completed machine. The engine shaft carries the armature and commutator directly attached to it.

The company also manufactures the large shafts and flywheel for many of the engine builders, and it is very convenient to have the entire engine, shaft, flywheel, armature and steel magnets made at the same place, as they are all fitted together in the shop, and everything is made fast and put in good order before shipment.

These are probably the largest power transmitting dynamos made in the world, and no pains are spared in making them perfect in every particular. They run from no load to full load, and even 50 per cent. overload, without the slightest sparking at the commutators or heating in any of the parts, and run quietly, without the noise common to large generators.

The brushes are all moved at one time by the hand wheel fastened to the base of the machine. The lower brushes and also part of the machine are reached by steps leading down into the pit below, so that every convenience for operation is provided for.

The facilities of the Walker Manufacturing Company for making large castings enable them to make every part of these machines. Each individual casting is made as large as is practicable to carry on freight cars and to erect in plants. These machines are arranged to be direct coupled to either vertical or horizontal engines, and also arranged to be attached to both tandem and cross compound and triple expansion engines. This company is also going largely into electrical apparatus for elevated railways and inter-urban and cross country railroad apparatus.



2,000-H. P. GENERATOR.

Resistance Standards.

A new standard coil, intended to be free from the objections incident to previous forms, has been evolved from the laboratory of Queen & Co., Philadelphia. It is of the oil immersion pattern, embodying features adopted by the German Reichsanstalt, but with important modifications of their own, rendering it more constant, accurate and convenient.

Fig, 1 shows a section through the centre. *S*, the standard coil made of platinoid, is wound on a metal cylinder the surface of which is covered with a thin coating of insulating material. On a similar cylinder inside of and concentric with the standard coil is wound the temperature coil *T*, similarly insulated. These two coils are immersed in a bath of specially treated resin oil contained in the chamber *M*. It will be noticed that the coils *S* and *T* are wound between the same limits of height and depth, and that the casing *V*, is perforated with many holes so as to allow the utmost freedom of circulation to the oil. *M*, in turn, rests in an oil bath and is surrounded by the concentric thin cylinder on which is wound non-inductively a coil of copper wire, *H*. This wire is placed in series with a generator of some sort and an adjustable resistance serves to maintain the temperature at any desired point.

Those who have made use of the oil bath and gas flame for this purpose can appreciate how great an improvement is the electrical method of heating for both constancy and convenience. The heat produced by *H* is equalized over the surface of *M*, and thence conducted to the interior parts. A double walled containing vessel with a space between the walls stuffed with asbestos, as shown at *I*, serves to render the apparatus independent of external heating or cooling effects. This point is of great importance where work of great accuracy is to be done. The ends of the standard coil are soldered to the inner ends of the terminals, which are made of massive copper similar in design to the standard

British Association ohm. The object in making the terminals so massive is to have their resistance negligible in comparison to the standard coil proper, so that any rise of resistance caused by the temperature of the terminals being higher than that of the coil may be so small a fraction of the resistance of the coil and terminals as to be safely neglected.

The design of the temperature coil is very ingenious. It

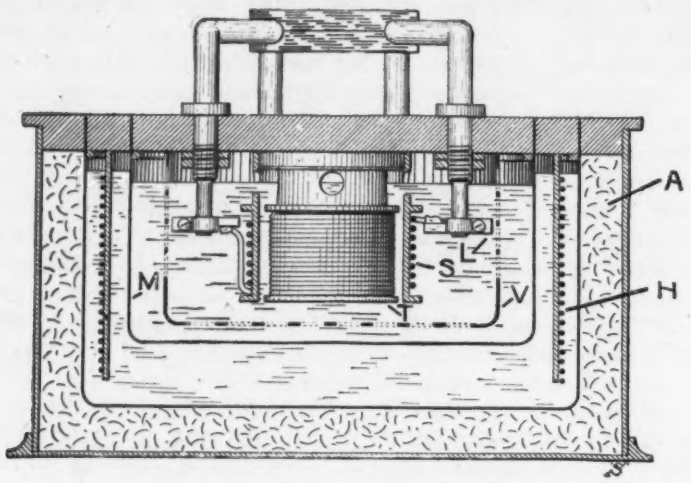


FIG. 1.—SECTION OF STANDARD RESISTANCE COIL.

is composed of copper and platinoid, the proportion of the total resistance supplied by each metal being so adjusted that for each degree centigrade rise in temperature the temperature coil increases its resistance 1-20 of one ohm measured in terms of the standard (i. e., measured by the standard without correcting for its temperature).

Fig. 2 shows the exterior view of the standard. *D* is a flexible wire serving to connect one of the terminals, *B*, of the temperature coil to whatever apparatus is used for the measurement of the resistance of that coil. The other terminal is exactly similar. *K K* are two terminals of the heating coil. The whole apparatus is readily dissectible. By unscrewing two nuts and lifting on the handle in the centre, the plate which holds the standard and temperature coils can be lifted out and both exposed to view. By unscrewing two other nuts the heating coil can be lifted out.

The method of comparing coils with the standard is this: Having a slide wire bridge and Carey-Foster commutator, connect the standard to one side and the unknown to the

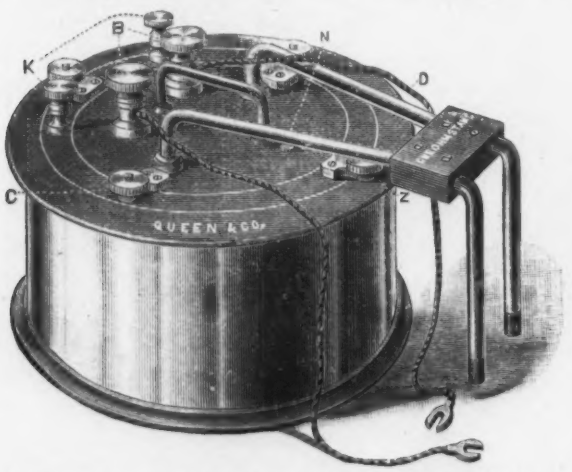


FIG. 2.—STANDARD RESISTANCE COIL.

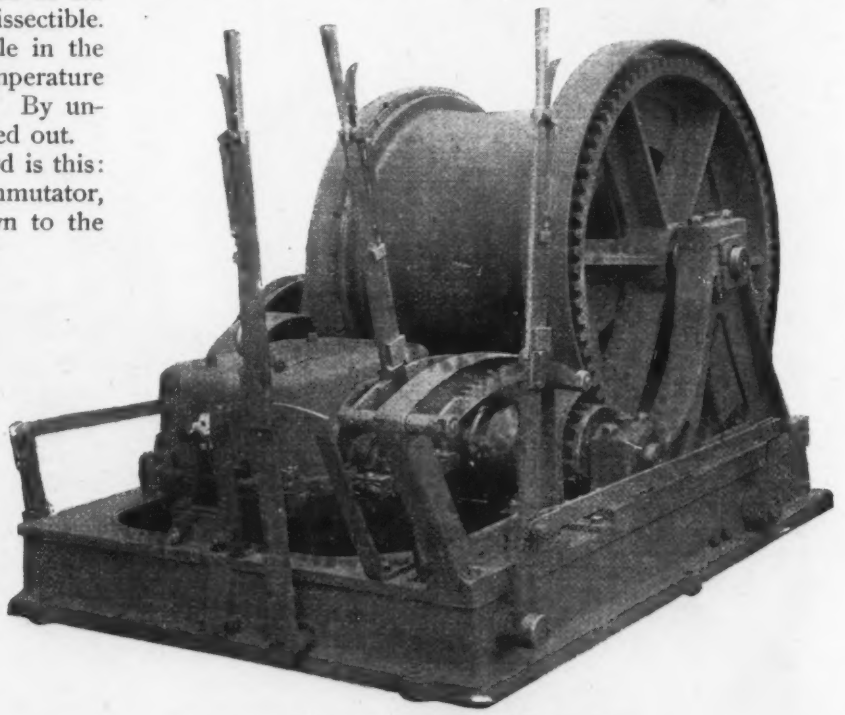
other side to the Carey-Foster. Adjust the slider until on depressing the key the galvanometer gives no deflection. Read the position of the slider and reverse the commutator. Adjust and read again. The difference in reading in millimetres multiplied by the resistance of a millimetre of the bridge wire in ohms gives the difference in resistance between the standard coil and the unknown (not corrected for the temperature of the standard). To make this correction, replace the unknown by the temperature coil and go through the same operation. From the difference of the two settings the resistance of the temperature coil is computed, and then simple arithmetic gives the temperature of the standard.

A very slight alteration of the design for the standard ohm makes a most desirable arrangement for the very important measurement of the temperature co-efficient of metals. If in place of soldering the standard coil to the heavy terminals, we arrange nuts so as to clamp specimens whose coefficient we desire, it is evident that we have with the Carey-Foster bridge all the apparatus necessary, for the specimen is in an oil bath, the heating coil serves for raising to any desired temperature and keeping it there and the temperature coil measures the temperature with great accuracy.

The use of a standard coil in connection with standard cells (or a voltmeter standardized by them) for calibrating a current meter, is very important where great accuracy is required. The only other apparatus necessary is a steady generator, rough adjustable resistance and a sensitive galvanometer. This method is used entirely in the Municipal Standardizing Laboratory of Vienna, where the potential measurements are mostly made by a Thomson balance.

Ironclad Motor Hoist.

The electric hoist continues to be improved. The General Electric Company has perfected its electric hoists, making them stronger, simpler and more compact. They are operated by motors of railway type, in which all moving parts are thoroughly protected. The motor and the hoist are mounted on the same bed-plate to which all bearings, levers, quadrants and other connections are attached, making the machine complete in itself. The drum is provided with a powerful hand brake, lined with wood and operated by a lever, and is thrown in or out of gear by a friction clutch of positive and reliable type, operated also by a lever.



IRONCLAD ELECTRIC HOIST.

The motor is controlled by a rheostat of standard type, which is thrown in or out by a lever. The pinion on the armature shaft and the intermediate gear with which it engages have machine cut teeth and are enclosed in an oil casing. The electric parts of the hoist are thoroughly insulated. These hoists are made in 4, 10, 15, 30, 50 and 90 h. p., as usually rated.

Financial Intelligence.

The Electrical Stock Market.

NEW YORK, June 2, 1894.

GENERAL ELECTRIC still suffers from the persistent attacks on its credit. The bear element spares no opportunity to assail the company's solvency. In the beginning of the week they even had it that the interest due June 1 on the 5 per cent. debenture bonds wold be defaulted on. Of course this was going beyond reasonable bounds, as the company has had the money for interest on hand all along, and the prompt payment yesterday of the June coupons showed how ill-grounded the reports were. But this is a good instance of the sensational rumors current on General Electric. A good part of the current gossip still has to do with the matter of making good the capital impairment. The scheme that attracts the most attention is the proposition to retire the $10,000,000 debenture bond issue. In another quarter the suggestion is made that the company be reconstructed by formation of another company, which should buy the General Electric Company on a basis of one share on the new for two shares of the old concern. A two-thirds vote to sell would fully establish the right of such a transfer. In the meantime the business of the General Electric Company has of late been showing a steady improvement, and insiders are again buying the bonds and shares of the property. Their acquisitions are not yet, however, on a sufficiently important scale to influence the course of quotations. The company is still pursuing the policy of concentration of expenses by consolidation of working forces. This week two more departments, the chemical and standard testing, were removed from Lynn to Schenectady. Officials say this policy will be adhered to until the administration of the entire property will be directed from the Schenectady offices.

WESTINGHOUSE ELECTRIC issues continue very strong on the growing belief that a dividend will be paid to common stockholders in July next. There is very good reason to believe that a gratifying distribution of profits will be made among the holders of the common stock. If the board of directors decide in July to postpone a little while longer the declaration of dividends on the common stock in order to continue the policy of building up the property out of net earnings, it is practically certain that the patience of the common stockholders will at length be rewarded in October. One thing is sure: When dividends on the common stock are once begun, they will be permanent, and, it is hoped, at a continually increasing rate. The business of the Westinghouse Electric and Manufacturing Company continues to keep pace with the record established in the last six months. In April orders amounting to about $800,000 were booked; May's business is understood to be fully as good, if not better.

AMERICAN BELL TELEPHONE stock has been carried up several points this week on the belief that the company will eventually succeed in its effort to secure increased capitalization. All indications point to the likelihood of legislative permission to increase the capital stock to $50,000,000, and insiders are again buying on the knowledge that issue to stockholders at par of $30,000,000 new stock is a privilege worth more than the present outstanding capital, as the premium to be given in rights on $30,000,000 new stock will amount to more than $20,000,0000 to the shareholders. There has also been good buying on reports that when the regular dividend of $3 per share is declared in July an extra $3 per share will be distributed.

THE STREET RAILWAY AND ILLUMINATING PROPERTIES, the trust that purchased some $12,000,000 General Electric treasury securities for $4,250,000 in order to liquidate floating debt, continues at regular intervals to furnish evidence as to the sacrifice made by the General Electric Company by its purchases of preferred stock out of the proceeds from the securities it holds. It has again bought 624 shares, at an average price of $96.09, as against an average price of $97.33 for 667 shares on April 27, and $97.54 for 2,054 shares bought on April 2. This makes a total of 9,955 shares of preferred stock purchased to date.

WESTERN UNION TELEGRAPH holds strong, a good deal of the recent buying being for bear account. President Eckert and Director John Terry both deny that earnings have so fallen off as to threaten the continuation of dividends at the present rate.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York	50	10	30
Detroit Electrical Works	10	2	3
Cleveland General Electric Co.	—	85	90
East River Electric Light	100	—	65
Electric Con. & Supply Co., pref.	15	15	16
" " " com.	75	15	17½
Edison Electric Ill., New York	100	98½	100½
" " " 1sts.	—	107	107½
Edison Electric Ill., Brooklyn	100	102	103 *
" " " Boston	100	117	118
" " " Chicago	100	130	135
" " " Philadelphia	100	125	127
Edison Electric Light of Europe	—	—	3
" Bonds	—	80	85
" Ore Milling	—	10	11
Fort Wayne Electric	—	3½	4
General Electric Company	100	35⅝	35½
" " " deb. 5's	—	86½	87
Interior Conduit and Ins. Co.	100	50	55
Mount Morris Electric	—	—	65
Westinghouse Consolidated	50	36	36½
" " " pref.	50	51½	52
Western Union Telegraph	—	82	—
American Bell Telephone	—	199	200

*Ex. Dividend.

New Incorporations.

THE INLAND ELECTRIC COMPANY, Chicago, Ill., capital stock $100,000, has been formed by Carl Pherson, Geo. E. Schumaker and Percy Taylor.

LANCASTER, PA.—The Citizens' Electric Light, Heat and Power Company has been organized with a capital stock of $100,000. J. L. Steinmetz, Chas. H. Locher and Allan A. Herr are directors.

THE WELLING MANUFACTURING COMPANY, New York, capital stock $25,000, has been formed to manufacture electrical goods and ivory. Wm. L. Welling, J. F. Baker and C. B. Riker are interested parties.

THE FORT WAYNE ELECTRIC MANUFACTURING COMPANY, Fort Wayne, Ind., capital stock $10,000, has been formed by Fred. Eckert, Wm. Orr, J. H. Orr, F. Eckert, Jr., H. Eckert and C. Orr, Fort Wayne, Ind.

THE ILLINOIS ELECTRICAL REMINDER COMPANY, Chicago, Ill., capital stock $25,000, has been incorporated to deal in electrical goods and machinery. The incorporators are W. C. Jones, H. L. Cragg and G. S. Buell.

THE COCKERILL ELECTRIC LIGHT AND CENTRAL TELEPHONE COMPANY, Jefferson, Iowa, capital stock $5,000, has been formed by C. G. Cockerill, H. S. Cockerill and Park Cockerill, and is to supply electrical apparatus, do wiring, etc., and will supply a telephone exchange.

THE ELECTRIC CAR LIGHTING COMPANY, New York, maximum capital stock $2,000,000, has been formed to light railroad cars by electricity, deal in machinery and apparatus for same, etc. The promoters are Theo. W. Myers, E. H. Myers, New York; L. D. Adler, M. Moskowitz, Newark, N. J., and A. S. Adler, Philadelphia, Pa.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, June 4, 1894.

H. WARD LEONARD was out of the city last week on business.

C. W. HOLTZER, of the Holtzer-Cabot Electric Company, Boston, was in town last week.

JOHN SEELEY, of the Complete Electric Construction Company, has gone West on a business trip.

MR. GEO. J. JACKSON, of the Norwich Insulated Wire Company, has gone to Boston on a business trip.

J. H. DALE, of the Dale Manufacturing Company, has gone West on an extended trip in the interest of his company.

THE BALL & WOOD COMPANY, Elizabeth, N. J., has found it necessary to increase its force by the addition of a night gang. Hereafter its works will be run to their full capacity, 24 hours a day, which speaks well for one of Elizabeth's youngest industries and for the reputation of the company's engines. By a singular coincidence it is exactly one year ago that the night gang was laid off in this establishment.

MR. J. H. VAIL a little more than a year ago organized the Electrical and Mechanical Engineering and Trading Company, 39-41 Cortlandt street, New York. The company has in hand a variety of business, among which may be mentioned the following contracts: Car house, cars, motors, trucks and generators for the Hoosick Railway Company, Hoosick Falls, N. Y.; lighting station and complete equipment at Rumsen Neck, N. J., for the Rumsen Improvement Company; lighting plant in new addition to Buckingham Hotel, New York City; underground conduit system, telephone system and electrical conductors for J. C. Hoagland and Raymond Hoagland, Rumsen Neck, N. J.; consulting engineers for Trinidad Electric Light and Power Company, Port of Spain, Trinidad; lighting system, underground conduits, pole line, etc., for Edward Kemp, Rumsen Neck, N. J.; supervising and consulting engineers for Poughkeepsie City and Wappinger's Falls Electric Railway Company. This railway system will involve a 600-h. p. steam plant, compound condensing engines and direct driven generators; there will be some fine long distance work, as one section of the road extends 10 miles to the towns of Wappinger's Falls and New Hamburg, operating cars in and between both towns. The plant will use Stirling boilers, compound condensing Ball & Wood engines, direct driven General Electric generators and G. E. 800 motors.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD.
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., June 2, 1894.

PALMER, MASS.—The Palmer & Monson Electric Company has been succeeded by the Central Massachusetts Electric Company.

MR. A. W. TOPPAN, formerly with the General Electric Company as meter expert and salesman, is now connected with W. L. Walker & Co., of Boston. Mr. Toppan is quite well known among the New England station men, and we congratulate the firm on having secured his valuable services.

THE AMERICAN ELECTRICAL COMPANY, of Providence, R. I., has purchased from the Morgan Construction Company, of Worcester, Mass., a complete rolling mill and electric wire-drawing apparatus.

MR. J. J. GATES, of Hartford, Conn., well known and highly esteemed in electrical circles everywhere, and prominently identified with the Royal Arc Electric Company, has been kept busy recently responding to congratulations. We are pleased to state that Mrs. Gates and the little daughter are doing nicely, while the face of our friend Gates never beamed with greater happiness.

MR. HENRY F. KELLOGG, general selling agent of the Whitney Electrical Instrument Company, recently started on a five months' trip to the Pacific coast, taking in, of course, on the way, all the principal cities, and presenting the well known merits of the instruments manufactured by this company, and which he has done so much to popularize. Mr. Kellogg's many friends wish him a thoroughly pleasant and unusually successful trip businesswise.

THE W. S. HILL ELECTRIC COMPANY, of Boston, has shipped during the present month two orders for switches that weighed over 11 tons, to one company, and reports that notwithstanding the unprecedentedly hard times, their gross sales for the past nine months average nearly 75 per cent. more than for the corresponding months of a year ago, which is certainly a magnificent record, and of which Messrs. Hill, Poor and Everett should feel deservedly proud.

WILLIAM L. WALKER & CO. is the title of a new electrical firm in Boston, with offices at 178 Summer street. It will deal in electrical apparatus and supplies, and will give especial attention to the purchasing and selling of second-hand apparatus, a branch of business in which Mr. Walker has had large experience and attained exceptional success, because of his excellent judgment and shrewd business ability. He possesses a wide acquaintance in the electrical field, who not only wish him every success, but will do all in their power to help him obtain it.

WEBSTER & BEACH, 620 Atlantic avenue, Boston, is a new firm, the members of which are so widely known as to hardly need an introduction—Mr. F. W. Webster having been the first and continuous purchasing agent of the Thomson-Houston company, and until recently holding the same position with the General Electric Company, while Mr. R. H. Beach has also been prominently identified with the same interests as purchasing agent for the St. Paul office, and more recently as manager of the railway supply department of the company in New York. The firm will give special attention to electrical appliances, carrying a full line of all kinds, and will act also as manufacturers' agents. Popular, reliable and energetic, both of them, it is hardly necessary to bespeak for them unusual success.

THE HIGHAM ELECTRIC COMPANY, 164 High street, Boston, is now ready for the conduct of business, and is actively engaged in the manufacture of its incandescent arc lamps. Mr. Daniel Higham is the president of the company, and Mr. J. G. Robinson its treasurer. The claims for this lamp are briefly: 92 per cent. of the total electrical energy is obtained at the arc, and solid carbons can be successfully used instead of cored ones. The total advantage of light for current compared to other lamps is claimed to be as much as 30 per cent. in favor of the Higham lamp. Professor Hooper, of Tufts College, in a recent report upon the lamp, says: "I regard the remarkable features of this invention to be, first, the employment of a simple and durable clutch lamp on a constant potential circuit; second, the use of the inductive coil in place of the usual 'dead' resistance, whereby two-thirds of the power usually wasted is saved; third, the extreme precision of the regulation, and the consequent steadiness of the light."

THE AMERICAN TOOL AND MACHINE COMPANY, 84 Kingston street, Boston, with factories at Hyde Park, Mass., a corporation which has been conspicuously and favorably before the public for over 30 years, has recently taken on new life in the form of a reorganization of its official staff. Mr. E. C. Huxley, one of Boston's most prominent and active business men, and who has earned for himself especial distinction in the line of mill construction work, becomes its president and general manager, and Mr. W. H. Hoffman, who has for a number of years been more or less associated with Mr. Huxley in his labors, and who was for a long period general superintendent of the Eastern works, at Hartford, Conn., of the Buckeye Engine Company, becomes the general superintendent of the company. Messrs. M. H. Barker, chief engineer; W. O. Lincoln, treasurer, and M. M. Whipple, superintendent of sales department, complete the official staff of the company, and are all of them, owing to their long connection with it, almost as well known as the company itself. Under the new deal it is almost needless to predict that the fortunes of the company will be greatly increased.

THE BROWN ELECTRIC COMPANY, Boston, has rearranged its present offices so that they not only present a more attractive appearance, but, owing to the locality of its store room in the upper part of the building, increased facilities have been obtained for the transaction of its business. The company is doing an excellent business, having closed during the past two weeks contracts for the equipment of 10 miles for the Norwalk (Conn.) Street Railway Company, six miles for the Gardner (Mass.) Street Railway Company, six miles for the North Weymouth branch of the Quincy and Boston Street Railway Company, and seven miles for the Calais (Me.) Street Railway Company. Several of the Harthan collapsible trolley wagons, of which the company is the sole New England agent, are being put together, and one will be delivered to the Plymouth and Kingston Street Railway Company early next week. This company has recently been appointed sole New England agent for the standard line of railway equipment manufactured by the Ohio Brass Company, of Mansfield, Ohio. Mr. H. P. Brown, travelling salesman for the company, has just returned from a trip through eastern New York with a good batch of electric light orders.

Canadian Notes.

OTTAWA, Ont., June 2 1894.

MONTREAL.—Last week the boiler of the East End power house of the Royal Electric Company, on Water street, exploded. The force of the explosion blew out the wall of the station, and one of the foremen was injured, but not fatally. Fortunately there were no serious results owing to the explosion. The whole of the east end of the city was plunged in darkness.

OTTAWA.—A bill has been introduced in Parliament by the Dominion Parliament respecting the unit of electrical measurement, and a bill "Respecting the inspection of electric light." The first bill simply establishes the standard of measurement now in use by electric companies as the legal standard. The other bill provides for inspection similar to that of gas companies. The work will be done by the gas inspectors.

HAMILTON.—It is likely that before the end of next summer Toronto and Hamilton will be connected by an electric railway. The Hamilton Radial Electric Railway will lay a branch to Burlington, where it will connect with the Toronto and Mimico line, which is now being extended westward. The cars in a few weeks will be running to Long Branch, and the latest idea is to extend the railway to Lorne Park this summer.

SIR ADOLPH CARON, postmaster-general, replying to a question asked him in Parliament, said that a contract had been made with the Ottawa Electric Railway Company for the carriage of the mails between the railway stations and the Ottawa post-office. This contract was for four years, dated Nov. 1, 1893, and was at the rate of $4,000 per annum, which included all additional trips required during contract period. The service by street cars was much superior to the wagons. The mails were delivered at the post-office with greater certainty and with greater safety. The large amount of space in the cars enabled the company to carry all the mails in one trip. The mail clerks were not exposed to the inclement weather under the new system. The amount paid on account of this particular service last year was $3,822.

THREE BILLS affecting the electric street car service and electric lighting of Ottawa have passed the House of Commons, viz.: An act to confirm an agreement between the Ottawa City Passenger Railway Company and the Ottawa Electric Street Railway Company, and an agreement between the said companies and the corporation of the city of Ottawa, and to unite the said companies under the name of "The Ottawa Electric Railway Company." 2d. An act respecting the Chaudiere Electric Light and Power Company (Limited), and to change the name thereof to "The Ottawa Electric Company." 3d. An act to incorporate the Ottawa Electric Light Company.

English Notes.

LONDON, England, May 24, 1894.

THOMAS PARKER, LIMITED.—Mr. Thomas Parker, the designer of the electrical equipment of the Liverpool Overhead Railway, whose services the Electrical Construction Company recently thought fit to dispense with, has now blossomed out into a limited liability concern, with a capital of £75,000. A great point is made in the prospectus of the fact that Mr. Parker owns the Eickemeyer armature patents for England. Mr. Parker's old company, however, has issued a notice announcing that they also have a license to use these patents, and containing threats of legal proceedings.

PERIPHERAL STATIONS.—The "Engineer" recently gave vent to the suggestion that it would be well for one single colossus to undertake to generate electricity for the whole of the metropolis, the existing concerns converting their present generating stations into distributing centres, and themselves into mere retail dealers in electricity. No doubt from the point of view of freedom from actions for damages and injunctions this idea has much to commend it, and in a letter in the same journal Mr. Kapp, whilst pointing out several inaccuracies in the figures given by the "Engineer," gives general adhesion to the principle of what he is pleased to call "peripheral stations."

THE CARDEW VIBRATOR.—Some years ago Mr. Melhuish, of the Indian telegraph service, read an interesting paper before the Institution of Electrical Engineers on "Signalling Across Rivers in India," a question of considerable importance in that country, by reason of the many big rivers and their eccentric behavior. Mr. Melhuish detailed a large number of experiments, all tending to establish the fact that a circuit containing a Cardew vibrating sounder as a transmitter, and a telephone as a receiver, may be relied upon to work under almost any conditions of line insulation. During some recent severe weather in Persia, an involuntary large scale experiment of the same kind was carried on by the Indo-European Telegraph Department with the same satisfactory result. On one occasion a long length of line lay buried under

mud and water, yet for four and twenty hours the international traffic was carried on uninterruptedly, messages being regularly transmitted between Ispahan and Shiraz, a distance of 332 miles, by means of Cardew sounders.

ELECTRIC LIGHTING AT ST. PAUL'S CATHEDRAL.—For some time past experiments in the electric lighting of St. Paul's Cathedral have been going on under the aegis of Major-General Webber. On Monday the "Daily Telegraph" came out with the following portentous announcement: "Some astonishment, as well as regret, will be felt when it is known that the experiment of lighting St. Paul's Cathedral by electricity has—at any rate for the present—proved a dismal failure. Every preparation had been made; the most skillful electricians had been consulted, and the latest appliances had been brought into requisition, but the result was very disappointing to all concerned. The distribution of light was irregular and inadequate, and the intensity of the shadows is said to have been positively gruesome." In a letter which appeared in the very next issue, all the allegations contained in the above paragraph were denied in toto by Major-General Webber, and before long it may be anticipated that the beautiful decorations which now adorn our metropolitan cathedral will cease to be cooked and smoked by gas.

ELECTRIC LIGHTING IN LONDON.—All the metropolitan electric lighting concerns having now sent in their regulation returns to the Board of Trade for the year 1893, I am enabled to give a few figures showing the present position of electric lighting in London. The total capital outlay of the 10 companies and one vestry engaged in the business of electricity supply amounted at the end of last year to nearly 3½ millions sterling, and as some 700,000 lamps were at the same date connected to the mains, the average expenditure per lamp connected comes out at £5, the lowest outlay being that of the Chelsea company, whose figure is £2 10s., and the highest outlay being that of the London Electric Supply Corporation (Deptford), which has spent no less than £13 for every lamp secured. As to the revenue and expenses, the former was nearly £300,000, and the latter nearly £200,000. Close upon 10 million kilowatt hours were sold to consumers at an average price of 6.38d., each 8-c. p. lamp connected yielding 7s. 6d. per annum. The coal of the London companies for 1893 aggregated £55,000, coal costing 1.328d. per unit metered. In this item the range between the best record, that of the Kensington company (three-wire), and the worst, that of the Metropolitan company (alternate current transformers), is very great; the figures being .74d. and 1.97d., respectively. The output for 1893, I may say, shows a 25-per cent. increase over that for 1892. The price of the kilowatt-hour continues to fall. Last week the Kensington company reduced its charge from 8d. to 6d., and the Westminster company from now offers its customers a day supply at 4d.

News of the Week.

Telegraph and Telephone.

SALISBURY, MD.—A telephone company has been organized at Salisbury.

COLUMBIA, S. C.—Niernsee & La Mott propose to establish a telephone system.

KNOXVILLE, TENN.—The East Tennessee Telephone Company will construct a line to Chattanooga.

APPLETON, WIS.—The Appleton Central Telephone Company office will be equipped with a new switchboard July 1.

PALESTINE, TEX.—L. C. Ketcham has petitioned the City Council for a franchise to construct a telephone system.

SUFFOLK, VA.—The Nansemond Telephone Company has contracted with W. N. McAnge & Co. for the building and equipping of its telephone lines.

THE PALATKA TELEPHONE COMPANY, Palatka, Fla., capital stock $10,000, has been incorporated. Marcus Loab is president and George Mundee secretary.

THE NATIONAL TELEPHONE COMPANY, Portland, Ore., capital stock $100,000, has been incorporated to do a general electrical business. E. P. Curtis is interested.

THE NORWALK TELEPHONE COMPANY, Norwalk, Ohio, capital stock $20,000, has been formed. H. B. Hanford, W. W. Graham and A. C. Greene are interested.

MOUNT PLEASANT, N. Y.—The town authorities have granted authority to a telephone company to string wires in Pleasantville and Unionville. The plant will be located in Chappaqua.

CHAPPAQUA, N. Y.—A franchise has been granted by the authorities of Mount Pleasant to a telephone company to string wires in Pleasantville and Unionville. The plant will be located in Chappaqua.

GLENS FALLS, N. Y., has adopted the Gamewell electric fire alarm system. The equipment will cost the town $2,800, and it is expected that it will be in working order in six weeks. The new alarm bell will weigh 2,500 pounds.

THE GROFF TELEPHONE COMPANY, Chicago, Ill., capital stock $1,000,000, has been formed to manufacture and sell magnetic and electric telephones, and devices pertaining to telephones, etc. E. M. Hoy, Joseph Klingensmith, L. E. Potteiger, W. Ream and W. R. Tucker are interested.

Electric Light and Power.

WILMINGTON, VT., is to have electric lights.

CUBA, N. Y.—The citizens have voted to have the electric light.

LONDONDERRY, VT.—Taxpayers are discussing the matter of electric lights.

ELLSWORTH, ME.—Estimates of cost for an electric light plant are desired by the mayor.

IRVINGTON, N. Y.—Taxpayers of Irvington are discussing the matter of a local electric light plant.

WATERBURY, CONN.—The new German Catholic church of St. Cecilia is to be equipped with electric lights.

MORRISTOWN, TENN.—A receiver has been appointed for the Morristown Electric Light and Power Company.

WEST CHESTER, PA.—Address A. P. Hall regarding the proposed electric lighting plant for the State Normal School.

PHILADELPHIA, PA.—W. Smedley, 435 Chestnut street, may be addressed concerning the electric light plant for the Woman's Hospital.

THE VICKSBURG ELECTRIC, TRANSIT AND LIGHTING COMPANY, Vicksburg, Miss., is preparing to erect an electric power plant.

PEKIN, ILL.—Directors of the electric light company have decided to erect a brick building, 36 by 56, and to put in another large engine and two more dynamos.

FOUNTAIN HILL, PA.—The borough proposes to light the village by electricity, and bids should be addressed to A. R. Ritter, secretary, South Bethlehem, Pa.

ST. LOUIS, MO.—The Missouri Electric Repair Company has received the contract from the Alton (Ill.) Roller Mill Company for an electric light equipment for its plant.

BALTIMORE, MD.—The present contract for electric lighting of the streets expires July 1, and bids will then be received from all companies which may choose to do the work.

PITTSBURGH, PA.—Address Longfellow, Alden & Harlow, Vandergrift Building, regarding the incandescent electric light plant for the Mt. Aloysius Convent, Cresson, Pa.

ST. LOUIS, MO.—The city subway commission has decided not to purchase the conduit and franchise of the St. Louis Underground Service Company, but to build a municipal system.

CLARKSVILLE, TENN.—It is reported that the Clarksville Electric Light Company is to sell its plant to St. Louis parties, who will continue its operation and add $10,000 worth of new machinery.

ESTHERVILLE, IOWA.—An election will soon be held here to vote on the matter of issuing $12,000 in bonds to put in an electric light and water plant, which a Chicago firm has agreed to put in operation.

ASBURY PARK, N. J.—On June 5 residents of Neptune township will vote in the matter of appropriating money for an electric light plant or for gas lighting. Neptune township adjoins Asbury Park.

FREDONIA, N. Y.—The board of trustees of Fredonia have granted permission to the Dunkirk and Fredonia Street Railway Company to erect poles and string wires on them, to furnish incandescent electric lighting for Fredonia.

BRADFORD, PA.—After a protracted meeting, a resolution was adopted instructing the joint finance committee to inquire into the advisability of the city owning an electric light plant, and to ascertain the cost of same and to confer with the present electric light company with a view to purchasing its plant.

WATERPORT, N. Y.—Articles of incorporation have been filed for the proposed Waterport Electric Light and Power Company, $40,000 capital, under which Capt. Lina Beecher proposes to build his single rail electric road at Batavia, N. Y. The trial line will be built between Waterport and Lakeside, about 3½ miles.

HILLSBORO, TEX.—The Hillsboro Electric Light Company is to establish an electric light plant with 750 incandescent and 30 2,000 normal c. p. arc lights. A contract has been made with the city government for street lighting. Address E. G. Shields for further information.

ALLEGHENY, PA.—The sub-committee on public lighting has contracted with R. C. Tannahill for the erection of an additional electric light plant on Braddock street for $25,893. The contract includes the erection of the buildings and equipment ready for the dynamos, and also the erection of two large iron carrying cranes.

PITTSBURGH, PA.—A continuance has been granted to the next term of court in the case of the Denver Consolidated Electric Company, of Denver, Col., against the Standard Underground Cable Company, of Pittsburgh. The plaintiff alleges damages by the defendant company laying cables of an inferior character for electric lighting purposes.

HAWARDEN, IOWA.—On May 26 the city authorities awarded the contract for its incandescent electric lighting plant to J. H. Winchel, Le Mars, Iowa, under plans and specifications prepared by Wm. H. Bryan, consulting engineer, St. Louis. Mr. Winchel will furnish a 36-kw. slow speed T.-H. alternator; 12 by 30 Corliss engine; two 80-h. p. steel boilers; primary and secondary construction for 1,000 16-c. p. indoor lights, and 50 32-c. p. street lights. The contract provides for the completion of this work within 90 days,

but in all probability the plant will be running much before that date, owing to the very favorable cash terms offered. This contract is said to have been placed "at the lowest figures ever known in the electrical industry."

The Electric Railway.

BRAZIL, IND.—An electric street car line is proposed between Brazil and Terre Haute.

BERLIN, CONN.—F. G. Platt says the electric road from New Britain will be in running order by Sept. 1.

SPRINGFIELD, MASS.—The directors of the street railway have voted to erect a new car house on Bond street. New cars have been ordered.

CLEVELAND, OHIO.—A company is organizing with $300,000 capital to establish an inter-urban electric street railway between Cleveland and Akron.

LEAVENWORTH, KAN.—The Leavenworth Electric Railway Company has been granted a franchise to build the Soldiers' Home and Mount Muncie extension.

LANCASTER, KY.—Fred Balcom may be addressed concerning the new electrical railway proposed between Lancaster and Nicholasville, a distance of 22 miles.

THE WEST END.—The bill to compel the West End Street Railroad Company to issue transfers on all its lines was defeated in the State Legislature this week.

RICHFIELD SPRINGS, N. Y.—There is a project on foot to build an electric road between Richfield Springs and Oneonta, a distance of 34 miles, at a cost of $7,000 a mile.

GARDNER, MASS.—The directors of the Gardner Street Railway Company have organized as follows: President, F. S. Coolidge; vice president, E. F. Blodgett; secretary-treasurer, J. A. Stiles.

NEW YORK, N. Y.—The Metropolitan Crosstown Railway and the Lexington Avenue and Pavonia Ferry Railway have consolidated with the Metropolitan Street Railway Company. Capital $13,500,000.

STOUGHTON, MASS.—The selectmen have granted permission to the Brockton Street Railway Company to occupy the streets of Stoughton with its road, provided it is completed on or before April 19, 1895.

GETTYSBURG, PA.—In the United States Court the motion of the United States Government to enjoin the Gettysburg Electric Railway from building a branch trolley road on the Gettysburg battlefield was denied.

LOS ANGELES, CAL.—The Los Angeles, Pasadena and Altadena Electric Railway Company will equip the Main street system with electricity. Chas. L. Strange and Hervey Lindley, of Los Angeles, are interested.

PITTSBURGH, PA.—The Beltzhoover and Amanda Avenue Street Railway Company, of which W. H. Wenrick, of Pittsburgh, is president, has been granted a charter, and will be 1½ miles long. It will be completed by winter.

DANVILLE, ILL.—The Danville Gas, Electric Light and Street Railway Company will expend $10,000 this season for new machinery in its power house. New boilers of 150 h. p. will be put in, and an engine of about the same capacity.

GOSHEN, IND.—A company has been organized at Goshen by J. J. Burns, J. H. McIlhany and others to operate the plant of the Goshen Street Railway Company. The company will be known as the Northern Indiana Electric Company.

Miscellaneous Notes.

THE BROOKLYN ELECTRICAL SOCIETY will hold its fourth regular meeting on Thursday evening, June 7, at the residence of R. I. Times, Jr., 26 Prospect place, Brooklyn. Thomas A. Bamford will give an illustrated talk on the construction of telephones.

WHERE RUBBER COMES FROM.—Mr. W. R. Brixey, in a letter to the New York "Tribune," states that in no case, to his knowledge, is a manufacturer of rubber insulated wire using cheap rubbers from the east coast of Mexico or Nicaragua, as claimed by a writer quoted in the "Tribune." The rubbers employed in compounds of high-grade insulated wires, Mr. Brixey states, are invariably rubbers purchased on the Amazon, either Madeira or fine Para, costing at present market rates from 65 to 73 cents per pound, according to age, though for mechanical purposes there are undoubtedly cheaper grades of rubber consumed.

THE EMERSON CUT-OUT SUIT.—A cut-out patent suit of interest to electric light companies was decided on May 29, at Philadelphia, in the United States Circuit Court by Judge Dallas. The suit was brought by Marshall Shapleigh, of Pittsburgh, against the Chester Electric Light and Power Company, to enjoin it from using a spring clip cut-out to prevent the burning out of incandescent lights when an excessive current is turned on. The cut-out in use by the Chester company is manufactured by the Emerson Electric Light and Power Company, of St. Louis, and Shapleigh claims that it is an infringement on his patent. Judge Dallas refused the injunction and dismissed the suit at the plaintiff's cost, on the ground that no infringement was shown. In his opinion Judge Dallas stated that he was "convinced by the pertinacity and soundness of the point made by the learned counsel for the defendants that their specific combination did not infringe the complainant's patent."

THE DOUBLE ARC LAMP PATENT.—The Cleveland "Plaindealer" publishes the following interview with Mr. S. H. Hamill, of the Brush Electric Company: "The suit of John E. Ridall, an agent of the Brush company, vs. the Brush company, is for royalties he claims on Mr. Brush's double arc lamp patents, which have been broadly sustained by repeated decisions of the United States courts. Notwithstanding the fact that the Brush company has expended from $100,000 to $200,000 to sustain these patents and secure large yearly royalties from them, yet owing to delays in the United States courts and the reluctance of the courts to award damages for sales made prior to decisions, the Brush company has not as yet been able to collect very much from the infringement of these patents during the past. Our accounting against the Western Electric Company, of Chicago, for instance, has covered a period of two years, and is not yet finished. They owe us something like $50,000. Our cases against the Westinghouse Electric Company, of Pittsburgh, for what are known as the United States company's lamps, have been won, and we should at least receive $60,000 from them when the accounting is finished. Mr. Ridall has no claim under his contract against the Brush company. If he has any claim at all it would be against customers in his territory who have purchased infringing lamps, and even then he probably could not collect more than from $10,000 to $15,000, because his territory simply covers Pittsburgh and a small surrounding country. Under any circumstances Mr. Ridall could hardly get anything from us until we secure damages from others."

Personal Notes.

MR. PAUL C. JUST has been appointed electrical engineer of Lincoln Park, Chicago.

MR. F. UPPENBORN, the editor of the "Elektrotechnische Zeitschrift," of Berlin, has, we have just learned from Germany, accepted the position of electrical engineer of the city of Munich. The well conducted journal of which he has been the editor since January, 1890, has, since his connection with it, been the leading electrical journal of Germany, and has been without a rival. It is the official organ of the leading national society of electricians of Germany, which corresponds to our Institute of Electrical Engineers, and contains the papers read at their meetings. In 1881 he became the editor of the first journal for applied electricity in Germany, the "Centralblatt fuer Elektrotechnik," a high-class technical paper, which was combined with the other at the time he became the editor of the "E. T. Z.," as the "Elektrotechnische Zeitschrift" is frequently called for brevity sake. Mr. Uppenborn is a well posted electrical engineer, and has conducted his paper from the standpoint of an engineer as distinguished from a mere journalist, and his paper therefore contains a wealth of well selected technical information; the only faults that might have been found with it—if they can be called faults—were that it frequently contained long articles which might better have been published in a purely mathematical journal, and that comparatively little attention was given to electrical matters outside of Germany. Mr. Uppenborn is also the author of an electrical engineer's pocket book, for some unknown reason called a "Kalender," which is published yearly, and is perhaps one of the best of its kind, and which is found in the pocket or on the desk of almost every German electrician. Mr. Uppenborn was born in 1859, and is therefore only 35 years old. Who his successor will be as editor of the "Elektrotechnische Zeitschrift" has not yet been announced, but from some recently published information we would not be surprised to find that it is to be Mr. Gisbert Kapp.

Trade and Industrial Notes.

THE MANHATTAN GENERAL CONSTRUCTION COMPANY, 50 Broadway, New York, is having a great demand for its Fleming woven wire dynamo brushes. The company is turning out about 450 of these brushes per week, and is 600 behind in orders.

THE NEW ERA IRON WORKS have been incorporated at Dayton, Ohio, with a capital of $50,000, to manufacture gas engines and iron specialties. Their engine, the "New Era," has been in successful operation for nearly two years. It will be built principally in the larger sizes, and special attention will be given its construction for private electric light plants.

THE ALLEN-HUSSEY COMPANY, general electricians, formerly of 225 Dearborn street, have removed their offices and store rooms to more commodious quarters in the Medinah Building, corner Jackson street and Fifth avenue, Chicago, where they will be pleased to explain the merits of their "loop system" of wiring to any one contemplating electric wiring for lighting purposes.

THE WHITE-CROSBY COMPANY is the style of the new firm which has succeeded J. G. White & Co. The main office is in the Equitable Building, Baltimore, and there are branch offices at 29 Broadway, New York, and in the "The Rookery," Chicago. The officers of the company are J. G. White, president; G. H. Walbridge, secretary and treasurer, and O. T. Crosby, chief engineer.

THE GENERAL ELECTRIC LAUNCH COMPANY is building at Morris Heights, on the Harlem River, New York, an electric

launch for Congressman Sorg, of Ohio. The launch is to be 46 feet over all, carrying two motors, twin screw, and 144 cells of the Consolidated Electric Storage Company's batteries, and will have a speed of 12 miles an hour.

THE MATHER ELECTRIC COMPANY, of Manchester, Conn., is bringing out a new type of railway generator of large capacity, with complete station equipment of entirely new and original design, and embodying a number of very important improvements in this class of apparatus. The Mather Electric Company has secured a number of contracts for future delivery of these new large generators on some of the most important electric railways in this country.

CHARLES A. SCHIEREN & CO., 51 Ferry street, New York, have received from the Savannah (Ga.) Electric Railway Company an order for a double perforated 16-inch belt for high speed generator work. The distance from the centre of driver to centre of driven will be 19 feet 6 inches, and the belt is to be made endless, all ready to be put on. The railway company states that they have had two of the Schieren belts in use in their power house for three or four years, and that they have given the most excellent satisfaction.

THE ALSITE ALUMINIUM COMPANY, of 106 Liberty street, New York, has discovered a new process of soldering aluminium by hard and soft solder, by which process the joints thus soldered, it is claimed, are rendered stronger than the metal itself. Among the many testimonials of the merits of this process recently received is one from the Franklin Institute, Philadelphia, which strongly attests the value of the process. The Alsite Aluminium Company also plates aluminium with gold, silver or nickel for the trade.

THE HARRISON NATIONAL TELEPHONE COMPANY, New York, has issued a pamphlet of testimonials to the merits of the Harrison telephone, of which the following, from Denver, is a specimen: "Replying to your favor, would state that I have run a complete circuit through the entire city of Denver, on the poles of the Denver Tramway Company, in close proximity to large electric wires and trolley wires. We attached Harrison telephones to the circuit. There was no induction, and the test proved perfectly satisfactory to myself and many prominent citizens of Denver.—R. L. Cresey."

THE THOMSON ELECTRIC WELDING COMPANY, Lynn, Mass., has acquired the patent rights for the United States for the Sauer petroleum engine, and is now preparing to furnish them in sizes of 2, 4, 8 and 12 h. p. Special attention will be given to the demand for isolated electric lighting plants for private residences, hotels, halls, churches, theatres, etc., and complete plants will be furnished, consisting of engine, generator and necessary appliances, together with wiring and fixtures, as desired. The cost of lighting from a dynamo run by one of these engines of 8 h. p. is shown to be less than one-seventh of the cost of gas jets, with gas at $1.50 per thousand.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, reports that it is doing a rushing business with the Meston alternating fan motor, notwithstanding the fact that the temperature has been rather against that electrical appliance. Hot weather is sure to come, however, and at least some of the trade believe in being prepared for it when it does come, instead of having to take their chances with the rest in the rush. The same company is exhibiting a line of the Carpenter electric heating and cooking appliances in its Madison street show windows, which are attracting considerable attention.

THE COLUMBIA CARRIAGE AND CYCLE COMPANY, of Milwaukee, has made arrangement to build an immense quantity of its celebrated road wheels this year, and wishing to get them more thoroughly introduced, they have made a net price to consumers, which they claim is lower than the same grade of wheel can be sold for on a wholesale basis, and therefore offers a splendid opportunity to obtain a high grade American wheel at a great reduction. The purchaser is not only secured by the reputation for reliability of this house, but also by a written guarantee, which it furnishes with all its wheels.

QUEEN & CO., Philadelphia, have placed upon the market a new tachometer for measuring the instantaneous velocity of shafts. The portable tachometer, reading from 40 to 3,000 revolutions per minute, is a particularly valuable instrument. Three spindles are geared to the rotating parts, each having a separate scale on the dial, so that the instrument is direct reading throughout its range. A detachable joint is supplied with an end slightly flexible transversely fitting any of the spindles. The flexibility acts as a safeguard against breakage, in places where the tachometer shaft is not applied exactly parallel to the shaft whose speed is to be measured. The scales are graduated from 40 to 200, 120 to 600 and 600 to 3,000.

ALMON & SARGENT, electrical engineers and contractors, at 620 Atlantic avenue, Boston, and 136 Liberty street, New York, have recently filled orders from the North River Electric Light and Power Company for six, class B, L. P. and D power transmitters, to be used in their New York City station. Also two class B transmitters for the Pelton Water Wheel Company, to be used at Jackson, N. H.; they have also received orders from Marr & Gordon, Barre, Vt., for one 30-h. p. generator and one 25-h. p. motor, to be used in transmitting surplus water power at their polishing works to stone sheds, a distance of 2½ miles, and also have the contract for the construction. They are also nearing the completion of wiring the fountain in St. Albans, Vt., for electric lights. This firm is doing an excellent business and deserves it.

THE CARPENTER ENAMEL RHEOSTAT COMPANY is moving its factory from Bridgeport, Conn., to Hoboken, N. J., in the new Factory Building erected by John C. Crevier, at the Fourteenth street ferry terminal. The company's factory will be very accessible in its new location, being less than 15 minutes distant from Union square, which will be a great convenience to its various customers having offices in New York City. The following is a list of the principal agencies of the Carpenter company: Chas. D. Shain, general selling agent, 136 Liberty street, New York City; the Central Electric Company, 173 Adams street, Chicago, Ill.; Walker & Kepler, 531 Chestnut street, Philadelphia, Pa.; William Oswald, 42 Union street, New Orleans, La.; R. C. Wiggins, 31 Milk street, Boston, Mass.; The Robins Electric Company, 830 Liberty avenue, Pittsburgh, Pa., and Owen Ford, Rialto Building, St. Louis, Mo. The officers of the company are: H. Ward Leonard, president; L. B. Gawtry, vice president, and Charles E. Carpenter, secretary and treasurer.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOOKER MANUFACTURING COMPANY, 2140 DeKalb St., St. Louis, Mo.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED MAY 22, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

520,033. ELECTRIC BATTERY; W. W. Burnham, Newton, Mass. Application filed Sept. 7, 1891. A battery having a perforated cover, a rod of circular zinc supported by the outer jar, a carbon electrode having a diminished head and a flexible band adapted to clasp the bevelled head and rest upon the cover.

520,050. SYSTEM OF ELECTRICAL CONVERSION AND DISTRIBUTION; T. H. Hicks, Detroit, Mich. Application filed Dec. 15,1892. This comprises a motor and converter, converter conductors terminating in separate commutators, and the motor field being wound with supplemental coils in circuit with one of the converter commutators.

520,061. RAILWAY SIGNAL DEVICE; F. E. Kinsman, Plainfield, N. J. Application filed Feb. 1, 1893. This comprises an electric signal, and a controlling magnet for stopping apparatus inefficient or unresponsive under the action of the current used in operating the signal.

520,062. APPARATUS FOR CONTROLLING THE MOVEMENT OF RAILWAY TRAINS OR VEHICLES; F. E. Kinsman, Plainfield, N. J. Application filed June 23, 1893. This comprises a controlling arm on the vehicle and a trip on the line of way, a fluid pressure device operating the trip, and a spring or other retractor tending to move the trip into position for engagement with the arm on the vehicle.

520,072. PEDAL GOVERNOR FOR ELECTRIC MOTORS; A. G. McKee, State College, Pa. Application filed July 13, 1893. The combination of a contact stud, a reversing stud, stop stud provided with an arresting rib, and a pivoted bar carrying a spring contact for engaging the studs.

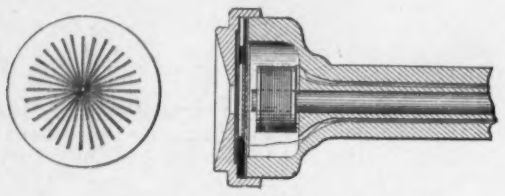
520,083. TELEPHONE TRUNK LINE SYSTEM; J. I. Sabin and W. Hampton, San Francisco, Cal. Application filed Feb. 12, 1894. The combination with a trunk line terminating in a switch at the operator's board, of single cord telephone lines terminating in connecting plugs thereat, and an operator's telephone set terminating in a switch socket.

520,086. TELEPHONE; H. F. Slocum, New York, N. Y. Application filed May 20, 1893. A diaphragm having a voltaic battery connected with the telephone circuit, arranged within the diaphragm so that the internal resistance of the battery will be varied by the changes of form assumed by the diaphragm. (See illustration.)

520,088. INCANDESCENT LAMP; F. S. Smith, Pittsburgh, Pa. Application filed June 28, 1893. The process of forming a tight seal at the leading-in wires, which consists in heating the wires, removing the scale in a pickle, dipping the wires into a bath of tin and moulding the wires into that portion of the chamber destined to surround them.

520,106. TRANSMITTING SOUND; H. B. Cox, Hartford, Conn. Application filed Aug. 6, 1890. This consists in recording sound vibrations and telephonically transmitting such recorded vibrations in condensed form.

520,108. ELECTRICAL TRAIN BRAKE; W. C. Fletcher, St. Louis, Mo. Application filed July 28, 1892. This comprises a generator, a circuit controlling the brakes, a switch on each car adapted to short circuit the brake on the car and a circuit which operates electromagnets connected to the switches to cut out the brakes successively.



NO. 520,086.—TELEPHONE.

520,111. ELECTRIC LOCOMOTIVE; R. M. Hunter, Philadelphia, Pa. Application filed April 25, 1893. This comprises a driving axle, an electric motor journaled thereon and having its weight supported thereby, a pivoted truck in advance of the driving axle, and a central pivot support between the truck and the motor. (See illustration.)

520,120. GALVANIC BATTERY; E. F. Northrup, Ardmore, Pa. Application filed Feb. 18, 1893. A battery having an electrolyte consisting of a mixture of zinc oxide and aluminium chloride in contact with the positive element, and a depolarizer consisting of iodine in contact with the negative electrode.

520,127. ELECTRIC ANNUNCIATING APPARATUS; H. E. Walter, Richfield Springs, N. Y. Application filed July 23, 1891. This comprises a series of contact buttons, forming terminals of sub-stations, gang switch having a rigid frame, means for mounting the switch to move in a curved path, tripping mechanism for holding the switch, and means for restoring the switch to its normal position after it has been tripped.

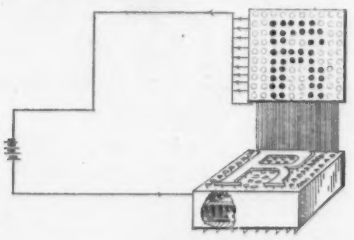
520,128. SWITCHBOARD FOR HIGH TENSION CIRCUITS; J. J. Wood, Fort Wayne, Ind. Application filed Feb. 6, 1894. This comprises a slab having a hole through it, a socket piece having a front flange and opposite ears, a fastening plate and screws passing through the plate and screwing into the ears to clamp the socket piece to the slab.

520,129. ELECTRIC CURRENT INDICATOR; J. J. Wood, Fort Wayne, Ind. Application filed Feb. 6, 1894. The combination of a coil, an armature pivoted to move therein, a spindle for the armature made of non-magnetic material, and having steel pivot pins inserted in its opposite ends, and pivotal bearings in which the pivots turn.

520,143. FORMER FOR WINDING ARMATURE COILS; H. L. Kirker and W. Chambers, Pittsburgh, Pa. Application filed Nov. 26, 1892. A coil former having broad and shallow wire ways at its sides, and deep and narrow ways communicating therewith at its ends.

520,152. DYNAMO ELECTRIC MACHINE OR ELECTRIC MOTOR; R. K. Welch, Philadelphia, Pa. Application filed June 24, 1891. A commutator consisting of a disc-like carrier and a series of segments secured to and projecting radially beyond the carrier so as to provide a narrow bearing for the current collector.

520,156. ELECTRIC RAILWAY TROLLEY; T. M. Brown, Cleveland, Ohio. Application filed Sept. 28, 1893. The combination of a base plate, a second plate, a contact device carried by the second plate, two parallel trolley poles, and universal joint connections between the poles and the two plates.



NO. 520,223.—ELECTRIC ADVERTISING OR SIGNALING APPARATUS.

520,169. BRUSH HOLDER FOR DYNAMO ELECTRIC MACHINES OR MOTORS; A. L. Riker, Brooklyn, N. Y. Application filed March 31, 1894. This comprises two contact plates hinged one to the other so that their contact faces are parallel in all positions of the plates with reference to each other.

520,184. ELECTRIC CLOCK STRIKING MECHANISM; F. L. Gregory, Chicago, Ill. Application filed April 27, 1893. The combination of a gong, a reciprocatory striker and switch actuator, an electrical striker-actuator, and a locking switch in circuit with the striker-actuator.

520,206. UTERUS BATTERY; C. S. W. Hinkley, San Antonio, Tex. Application filed April 10, 1894. This comprises a rigid stem formed of substances which are conductors of electricity, and a button or body connected to the stem.

520,213. TROLLEY WIRE HANGER; T. J. McTighe and S. W. Childs, New York, N. Y. Application filed Jan. 23, 1893. The combination of a U-shaped metal clip, an ear having an inclined bottom edge, a wedge and two or more rivets uniting the clip to the ear.

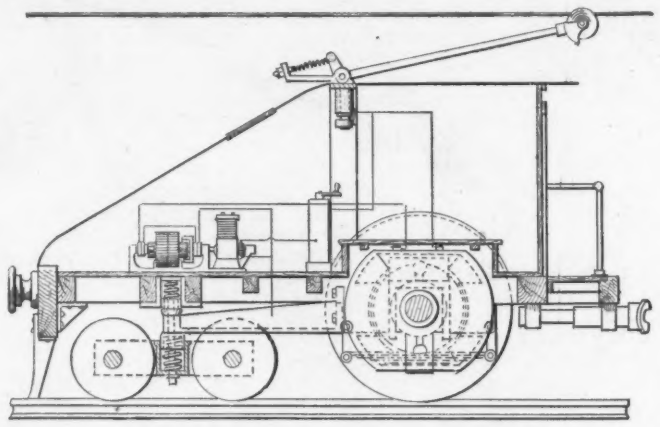
520,223. ELECTRIC ADVERTISING OR SIGNALING APPARATUS; G. L. Schneider, San Francisco, Cal. Application filed Jan. 20, 1894. This consists of a mat of lights, contacts in electrical connection therewith, a corresponding series of push buttons adapted to make and break connection with the contacts, and suitable electric circuits. (See illustration.)

520,228. ELECTRIC LOCOMOTIVE; R. Eickemeyer, Yonkers, N. Y. Application filed June 18, 1891. A motor casing having its sides, bottom and armature frame seamless and integral, and also having integral rectangular extensions or arms, containing jaws for the reception of the car axle boxes.

520,232. ELECTRIC ARC LIGHTING SYSTEM; D. Higham, Boston, Mass. Application filed Jan. 2, 1894. This comprises an induction coil in the main circuit in series with the arc and series windings with the lamps, and an elastic and slow yielding connection arranged serially together between the mechanism and frame of the lamps.

520,234. INDICATOR FOR FIRE ALARM OR OTHER PURPOSES; W. H. Kirnan, Bayonne, N. J. Application filed Jan. 18, 1892. This comprises a number of drums controlled by impulses employed in giving the alarm, and a tripping device to govern the movement of the drums.

520,246. AUTOMATIC TELEPHONE SYSTEM; L. E. Simoneau, Montreal, Canada. Application filed July 11, 1893. This comprises a box containing a telephone, a door, and spring actuating parts for automatically throwing the same open.



NO. 520,111.—ELECTRIC LOCOMOTIVE.

520,263. CARBON SWITCH; F. Von Hefner-Alteneck, Berlin, Germany. Application filed Nov. 15, 1893. This comprises a carbon switch, a worm wheel and worm shaft, an inner journal for the shaft, a switch lever carrying contacts connected with the line wire, and a link between the parts.

520,264. COMMUTATOR; C. Hoffman, Berlin, Germany. Application filed Sept. 28, 1893. The combination with a commutator bar comprising a base bar and a removable contact bar, of a common retaining key therefor.

520,267. ELECTRICAL GOVERNOR; W. H. Miller, New York, N. Y. Application filed June 18, 1884. The combination with a dynamo of a regulator comprising a magnet, an armature, means for connecting the armature with adjustable brushes, and mechanism for maintaining the pull of the armature constant.

520,274. ELECTRIC RAILWAY; E. W. v. Siemens, Berlin, Germany. Application filed Sept. 30, 1892. This comprises an insulated overhead slotted tubular conductor extending along a line of railway, and an electrically propelled car having a travelling contact within the tubular conductor.

520,279. ELECTRIC SWITCH; H. E. Werline, Lancaster, Pa. Application filed Feb. 15, 1893. This comprises contact plates, a switch spindle, a conducting brush bar secured thereto, spring actuated brushes attached to the brush bar and adapted to engage the contact plates.

520,304. CONDUIT ELECTRIC RAILWAY; W. R. DeVoe, Shreveport, La. Application filed Jan. 20, 1894. A lining section for underground electric railways comprising a metallic plate, having integral lateral upward flanges, and an intermediate upward, hollow integral flange.

520,356. CONDUIT ELECTRIC RAILWAY; C. W. Siemens, deceased. Application filed Oct. 19, 1893. In an electric railway system, a continuous underground chamber having hinged or removable covers giving access thereto, channel irons located at intervals within the chamber, and a conductor supported by the channel irons.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address ***The W. J. Johnston Co., Ltd., 253 Broadway, New York.***